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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

MUSSELSHELL RIVER BASIN
MONTANA

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN
MUSSELSHELL BASIN, MONTANA

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I. INTRODUCTION

The Musselshell River originates at the confluence of its North and South Forks east of Martinsdale, Montana. From its origin, the river flows in an easterly direction (125 miles, 201 km) on the southern flank of the Little Belt and Big Snowy Mountains. The river then flows northward (55 miles, 88.5 km) to Fort Peck Reservoir. The Musselshell Basin is one of 16 basins designated by the State of Montana for water quality management plans.

This report presents information relative to water quality and water quality inventory and management in the Musselshell River Basin (Figure 1, Plate I). Also included is a description of the physical characteristics of the basin and a brief discussion of basin biological conditions. The objectives of this effort were to provide the state with water quality data and related information in order to:

1. determine the water quality characteristics of natural waters and wastewaters;

2. determine those factors, both natural and man-made, which affect the quality of water;

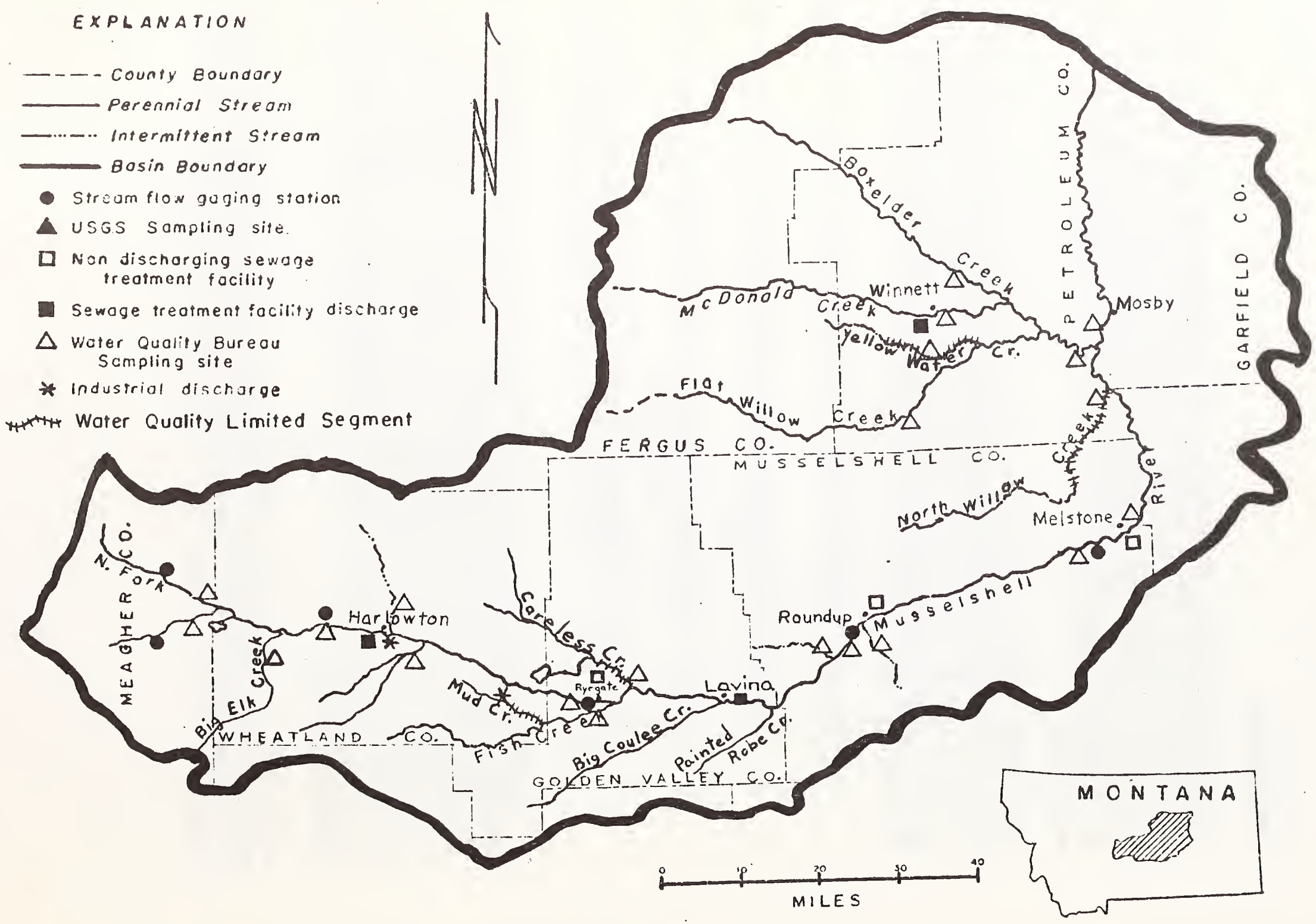
3. develop a management strategy for maintaining and enhancing the quality of waters in the basin;

4. and provide information needed to determine whether Montana's water quality standards are being met and will continue to be met.

The general methodology used in this study was first the compilation and evaluation of existing water quality data and related information. Secondly, where information was deficient, field investigations and water and wastewater sampling and analyses were conducted to obtain needed information. This report does not present a detailed analysis or inventory of the basin's resources but summarizes water quality related information. As additional information becomes available, the Musselshell basin water quality management plan will be revised and updated as a part of Montana's planning process.

Acknowledgments are due Mr. Jim Nybo and Mr. Dave Ricks, Montana Department of Natural Resources and Conservation for the sections on Population and Economy and Land Use, respectively; and Mr. Clint Bishop, Montana Department of Fish and Game for the fisheries information.

Figure 1. Sketch Map Showing Musselshell River Basin



II. SUMMARY AND CONCLUSIONS

Advent of the Milwaukee Railroad in the 1900's began a new era for the Musselshell Basin. The railroad provided the means for economic growth, settlement, and transportation. Placement of the railroad bed and associated diversions resulted in straightening of the river and removal of ox-bows. Thus began the slow decay of the Musselshell River. These modifications resulted in faster flows, greater erosion, warmer temperatures and loss of valuable fishery habitat. From this point in time, the Musselshell River may have remained relatively stable until the advent of modern agriculture. The changes on the river are now more subtle, but nonetheless real. These slight changes on water quality included increased salt and sediment loads.

Recorded tons of sediment discharged at Mosby vary from 100,000 to 350,000 tons per year. Sediment yield (in tons per square mile per year) from basin counties are: Golden Valley - 100, Musselshell - 200, Wheatland - 40, and Petroleum - 500. Petroleum County is 44 percent publicly owned and has the basin's highest sediment yield. Adequate soil conservation is present on about 33 percent of the area's rangeland (SCS 1968). If sediment loss is to be avoided, an adequate conservation program must be initiated and maintained.

Concentrations of sodium and sulfate continually show downstream increases in the Musselshell River. These increases are resultants of natural saline soils and irrigation return flows.

Municipal dischargers are located at Winnett, Harlowton; while Lavina, Broadview, and Melstone have intermittent discharges. Non-discharging lagoons are located at Ryegate, Roundup and Grass Range. Harlowton is currently in the planning stage for upgrading their wastewater treatment system. Industrial discharge permits were issued to Milwaukee Railroad, Harlowton, and J. Burns Brown, Shawmut. The Milwaukee Railroad effluent is treated by a link belt separator. The J. Burns Brown effluent is from an abandoned oil well which flows into Mud Creek.

Five agricultural discharge permits have been issued with one permit pending. All have adequate adjacent lands for disposal of solid wastes. Those permittees near state waters have provided appropriate retention ponds for holding of excess feedlot runoff. Even though this basin contains 60,000 irrigated acres, no irrigation companies have requested discharge permits.

Water quality problems in this basin are dominantly non-point source oriented. Water quality problems from these non-point sources are predominantly sediment and salinity. Toxic metals were not observed to be a basin water quality problem. Fecal coliforms in excess of state standards were recorded at various basin sampling sites; while high concentrations of nitrate were recorded throughout the basin.

Due to salinity, temperature and sediment, Painted Robe, North Willow, Mud, Yellow Water, Big Coulee and Careless Creeks are designated water quality limited.

Basin problems needing further investigation are saline seeps and salt accumulation in the Musselshell River. Future problems may be encountered from coal production and oil exploration. Water is critical to the basin's economy; thus, steps must be taken to prevent further stream degradation. Water demands by energy development may cause additional problems to irrigated agriculture. Stream salinity is a major problem in the basin and is becoming a factor in the basin's economy. Basin problems are summarized in Table 32.

III. RELATED INVESTIGATIONS AND PLANS

Early investigations in the Musselshell Valley were concerned with the availability of water for irrigation purposes. These investigations were presented in Water Resources Surveys for the following counties: Meagher I & II, 1950; Musselshell I & II, 1949; Golden Valley I & II, 1949; Wheatland I & II, 1949; and Rosebud I & II, 1948. Unpublished Water Resources Surveys are also available for Petroleum, 1970 and Garfield, 1971 Counties. Information on the latter two surveys may be obtained from the Department of Natural Resources and Conservation (DNR&C), Helena, Montana. Comprehensive areawide water and sewer plans are available for Wheatland, Golden Valley, Musselshell, Rosebud, Petroleum, and Garfield Counties (1970).

An abbreviated discussion of soils and vegetation types is found in Musselshell River Area (BLM, 1971). The feasibility of a dam on the lower Musselshell River is discussed in Water Quality Control Study Lower Musselshell Unit, Montana (FWPCA, 1966) and Status Report on Lower Musselshell Unit (Bureau of Reclamation, 1967). The former report concludes that salt accretion would be a problem and could only be alleviated by fewer acres under irrigation or by flow regulation. The latter report presents information on economic and financial feasibility of development. The status report stated that a suitable water supply is available; however, water quality deteriorates in downstream portions of the basin. An investigation by Vorozilchak (1973) discusses the alkali problem in the Deadman's Basin area. This study concluded alkali problems are a result of alkali soils and canal seepage.

Flow records maintained by the U. S. Geological Survey (USGS) are available from USGS Surface Water Records. Water quality data is available from Mosby and Flat Willow Creeks, 1963-1966. Zimmerman (1956) describes the geology and groundwater in parts of Musselshell and Golden Valley Counties.

A 1972 study by the Bureau of Reclamation gives an analysis of land, water, and mineral resources in eastern Montana. This report also discusses counties within the Musselshell Basin.

Investigations and data collection currently in progress are: National Stream Quality Accounting Network (USGS) Musselshell River at Mosby and Aquatic Insects of the Musselshell--Montana State University.

AREAWIDE WASTE TREATMENT MANAGEMENT PLANS

Harlowton is the only community utilizing Section 201 grant funds for preparation of facility plans. This will provide the necessary step to alleviate an overloaded waste treatment facility. Rosebud County is in the Yellowstone-Tongue 208 planning area. However, the results of this plan will probably be directed at that portion of Rosebud County in the Yellowstone River basin.

LEVEL B PLANS AND OTHER FEDERAL PLANS

By definition of U. S. Water Resources Council (1970) the water quality management plan for the Musselshell may be considered a level B plan. This basin management plan partially fulfills the step between framework and implementation studies.

The Bureau of Land Management (BLM) has divided the Musselshell Basin into eight planning areas. These plans are called Management Framework Plans (MFP), and the information is available at the District BLM office in Lewistown, Billings and Miles City.

VI. GENERAL BASIN CHARACTERISTICS

The Musselshell River flows through Wheatland, Golden Valley, and Musselshell Counties. The river forms the respective east and west boundaries of Petroleum and Garfield Counties. The Musselshell River and its tributaries drain an area of approximately 8,000 square miles (27,720 sq. km).

The basin terrain may be generally described as hilly to moderately sloping land. Mountain ranges occurring in or around the study area are the Castle Mountains (Meagher County) and foothills of the Little Belt and Big Snowy Mountains in Wheatland, Meagher, and Golden Valley Counties. Musselshell Basin land use is predominantly agricultural. Grazing land is abundant in the basin with the more desirable farm land located in the valley proper.

Harlowton and Roundup are the two largest communities in the basin with populations of 1,600 and 2,500, respectively.

All surface waters within the Musselshell Basin have been classified by the State of Montana according to use and existing water quality. B-D_1 classifications were assigned to American Fork Creek and the Musselshell River from and including Hopley Creek near Harlowton. Water of this classification is to be maintained suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. The Musselshell River from Hopley Creek to, but excluding Half Breed Creek near Roundup and Flat Willow Creek drainage is classified as B-D_2. Water of this classification is to be suitable for the marginal propagation of salmonid fishes and associated aquatic life. The remainder of the Musselshell Basin is classified as B-D_3. To meet this classification, water quality is to be maintained suitable for growth and propagation of non-salmonid fishes and associated aquatic life. Montana water quality standards applicable to the basin are given in Appendix F.

CLIMATE

The Musselshell basin is best described as a semi-arid region with a short growing season. The average annual precipitation ranges from 11.64 inches per year (29.1 cm) to 13.41 inches per year (33.5 cm). Forty to fifty percent of the rainfall occurs in the spring months; June being the wettest month of the year.

The average annual temperature ranges from 43.2^{o}F to 47.1^{o}F. The warmest average annual temperature occurs in July. Extreme low temperatures are recorded during December.

Table 1

Climatological Data from Communities in the Musselshell River Basin

Mean Temperature

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Flatwillow	19.6	25.9	30.8	44.1	53.9	61.3	70.6	68.9	58.0	48.2	34.2	25.3	45.1
Grass Range	21.2	26.8	30.9	43.0	52.4	59.5	68.1	66.6	56.2	47.5	34.4	26.3	44.4
Harlowton	21.6	26.8	30.2	41.9	51.1	57.7	66.1	64.0	54.2	45.8	33.0	25.7	43.2
Melstone	20.5	27.0	32.6	45.4	55.2	63.2	71.9	70.2	59.0	49.1	35.1	26.1	46.3
Roundup	23.2	29.2	33.6	45.9	55.4	62.9	71.7	70.1	59.1	49.7	36.1	28.0	47.1

Precipitation Normals

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Flatwillow	0.44	0.34	0.59	1.15	2.41	3.27	1.42	1.14	1.18	0.67	0.44	0.40	13.45
Grass Range	0.63	0.47	0.81	1.36	3.04	3.77	1.61	1.40	1.49	0.83	0.64	0.50	16.55
Harlowton	0.41	0.38	0.55	0.80	2.25	3.23	1.28	1.05	1.23	0.68	0.48	0.41	12.75
Melstone	0.49	0.44	0.57	1.17	1.99	3.10	1.44	1.15	1.26	0.76	0.53	0.51	13.41
Roundup	0.35	0.30	0.46	0.83	2.10	2.84	1.26	1.09	1.11	0.61	0.36	0.33	11.64

Reference: Climatography of the United States No. 81 (by State) Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941-70. U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), August 1973.

The community of Grass Range receives the most precipitation, while Roundup is the driest and warmest recording station in this basin (Table 1).

HYDROGEOLOGY

Groundwater is used extensively in the Musselshell River basin primarily for stock and domestic purposes and, to a lesser extent, for industrial, municipal, and irrigation uses. Groundwater is widely available and is a vital resource in the basin. There are several technical reports that describe geology and hydrogeology of portions of the basin. The occurrence, availability, and quality of groundwater in the basin is dependent on geological conditions. Geological formations of interest in the basin include formations of Paleozoic, Mesozoic, Tertiary, Pleistocene, and Recent age.

Bedrock formations of Paleozoic age (225 to 600 million years old) are found in the western and northwestern portions of the basin and are dominantly limestones, quartzites, and sandstones. These formations generally are present in the mountainous areas and will yield small to large quantities of fair to good quality groundwater. The most widespread and most widely used bedrock formations in the area are those formations of Mesozoic age (65 to 225 million years old). Rocks of Mesozoic age are present throughout most of the basin. Sandstones are by far the most important groundwater-bearing rocks of the Mesozoic age and they will yield small to moderate quantities of fair to poor quality water to wells. These bedrock formations are widely used as sources of water supply in the basin.

The Fort Union Formation of Tertiary age is present in the central portion of the basin near Roundup. The greatest thickness of Fort Union Formation occurs in the Bull Mountains southeast of Roundup, where nearly 2,000 feet of strata are present. The Fort Union, in this area, consists of two members, the Tongue River Member (upper) and Lebo Shale Member (lower). The Tongue River Member consists of about 1,700 feet of beds of massive, yellowish to buff, sandstone, clay, shale and coal. The Lebo Shale Member consists of about 300 feet of dark, olive-green to brown, sandy shale and thin-bedded sandstone with beds of carbonaceous shale, sandstone and coal. Wells penetrating sandstone beds that are not too fine-grained and that lie far enough below the ground surface to be saturated will yield adequate amounts of good to fair quality water for stock and domestic use. Coal beds in the Fort Union Formation that lie below the water table usually yield small to moderate amounts of fair to poor quality water. The Fort Union Formation contains commercial coal beds that are under development southeast of Roundup.

Terraces of unconsolidated gravel are present on uplands in the northwestern portion of the basin. Where the terraces are of Tertiary age and where they

are thick enough, they generally contain small quantities of water. Terrace gravel, bordering mountainous areas north of Harlowton, reportedly reach a maximum thickness of about 200 feet. Locally, where there is sufficient thickness, small supplies of fair to poor quality water can be obtained from wells drilled into the terraces.

Recent alluvium, youngest of the sediments, consists of unconsolidated mixtures of clay, silt, sand, and gravel that were deposited in lakes and along streams. These deposits are of Pleistocene and Recent age and are generally present in thin to moderately thick layers along the larger rivers and tributaries in the basin. These alluvial sediments generally will yield small to moderate quantities of fair to poor quality water to wells.

Pollution of groundwater has occurred in some areas in the Musselshell River basin. Probably the most severe groundwater pollution in the basin is in the vicinity of Roundup and Ryegate where saline seeps have appeared in the past few years. Saline seeps are caused by infiltration of precipitation and solution of soluble salts followed by evaporation at points of groundwater discharge. This problem is under investigation by numerous organizations. In addition to saline seeps, irrigation developments within the basin, such as Dead Man's basin, have created saline groundwater problems. Generally, percolation of irrigation waters and return flows of irrigation waters to streams causes an increase in salinity. Sewage stabilization lagoons generally have seepage into the groundwater and create localized areas of groundwater pollution. However, there have been no problems due to lagoon seepage reported from the seven lagoons in the basin. Septic tank and subsurface disposal also can create localized areas of groundwater pollution. Where there are large numbers of septic tanks and individual water supplies using wells, groundwater pollution can occur if the septic tanks and wells are improperly designed and located. No such problems have been identified in the basin although additional investigation of this problem is needed. There are numerous feedlots in the Musselshell River basin particularly along the larger streams. Water percolating through feedlot wastes can create localized areas of groundwater pollution; however, to date, no specific groundwater problems from feedlots have been identified.

SOILS

Soils of the Musselshell River basin are as varied as the physiographic features. The valley of the Musselshell averages less than a mile wide, is bordered by sandstone rimrocks and rugged shaly breaks along most of its course. Soils that have developed in these eroded lands are generally loamy to clayey in texture and are generally less than 20 inches deep. These soils present a high erosion hazard and contribute to the sediment load of the river. The eastern part of the area is part of the dissected plains which slope gently to the north and east. The weakly consolidated shales have been strongly eroded creating clay hills and ridges separated by relatively wide saline flats. Soils developed in this area are generally clays or clay loams with varying depths to bedrock. Surface run-off is a problem due to the low permeability of the soils. Exposures of sandstone have eroded to form high ridges and deep depressions. Loams, fine sandy loams and sandy loams have developed and the subsoil often has the structure and stratification of the parent material. An erosion potential exists with these soils.

In the Bull Mountains the soils were derived from siltstone and some sandstones. Most are silt loams and fine sandy loams and range from a few inches to several feet in depth. Little of this area is farmed due to rough topography and shallow soils. Soils in the Musselshell Valley along the river developed from alluvial material derived from the surrounding countryside. The soils are mostly silt and clay loams but textures range from loamy sands to clays. Many of the heavier textured soils are deep and have a high moisture holding capacity, rendering them adaptable to leveling and application of irrigation water. Accumulation of salts is a distinct problem and careful water management practices must be exercised.

The dominating physiographic features of the western portion of the Musselshell River basin are the Musselshell River Valley, adjacent benchlands, terraces, alluvial fans and the mountains. Soils on the benchlands are dominated by moderately deep, well-drained loams and clay loams. Some of the terraces have loamy soils that are highly calcareous. Soils on the alluvial fans are generally skeletal with a loamy or sandy texture. Since many of these soils present a moderate erosion hazard, good grazing and dryland management practices should be exercised.

Little soils investigation has been conducted in the rough, mountainous land of the Musselshell River basin. General observations indicate these areas are dominated by steep, shallow, stony and rocky soils that are used for grazing, timber watershed, and recreation.

LAND USE

The largest land use within the Musselshell River basin is privately owned rangeland. This use constitutes approximately 67% of the total basin. The next largest use classification is federal non-crop which includes all federal lands in the basin that are not being farmed. This classification accounts for 15% of the land area, and it may be assumed that the majority of this land is also being used as rangeland. The other major land uses within the basin are as follows: cropland - 7%, forest - 7%, pasture - 2%, urban and built up - 1%. The remaining 1% is split up between small water areas, from 2 to 40 acres in size, and land that has no specific use such as rock outcrops, etc. State land ownership amounts to 7 per cent.

Irrigated lands account for 88,831 acres of the basin. This land would fall in both the cropland and the pasture categories. Primary irrigated crops grown are hay, mostly alfalfa, and silage. Irrigated pasture is the third largest single use of irrigated land. Grain and hay are the major dry-land crops in the basin.

WATER USE

The basin's largest water consumer is irrigation. Total water diverted for this use is approximately 477,194 acre-feet annually. Of this figure, 334,260 is delivered to the farm and 116,919 are consumptively used by the crops. Return flows are approximately 252,119 acre-feet and the total depletion figure is 225,075 acre-feet. These figures are all approximate and are based on 70% delivery system efficiency and a 35% farm efficiency. Some regulation of the Musselshell is provided by Bair, Martinsdale, and Dead Man's Basin Reservoirs. All are state-built projects.

Municipal water use in the basin accounts for 114 acre-feet per year. A total of 8 basin communities utilize groundwater as their municipal source. Other water usage in the basin, i.e., industrial and stockwater is negligible.

POPULATION AND ECONOMICS

The Musselshell River Basin comprises all of Wheatland, Golden Valley, Musselshell and Petroleum Counties, and parts of Meagher, Fergus and Garfield Counties. All of the population in the basin, estimated at about 9,450, is considered rural by the U. S. Census; less than one half live in communities of 100 or more.

TABLE A

Communities of 100 or More Persons

Community	County	1970 Population
Forest Grove	Fergus	100
Grass Range	Fergus	181
Roy	Fergus	118
Lavina	Golden Valley	169
Ryegate	Golden Valley	261
Martinsdale	Meagher	150
Melstone	Musselshell	227
Musselshell	Musselshell	150
Roundup	Musselshell	2,116
Winnett	Petroleum	271
Harlowton	Wheatland	1,375
Judith Gap	Wheatland	160
Two Dot	Wheatland	102
Broadview	Yellowstone	120

The population in 1970 was about half its 1930 size and is projected to continue to decline as job opportunities decline.

TABLE B

Population and Employment, Historical and Projected, 1930-1985

	1930	1940	1950	1960	1970	1980	1985
Population	17,131	13,424	12,656	11,815	9,446	8,096	7,292
Employment	6,582	4,612	4,891	4,232	3,664	3,034	2,757

Agriculture is still the main employment sector, though it employs only about one third as many workers as it did in 1930. Surprisingly enough, the large decrease in basin agricultural employment has not been accompanied by a decrease in service or derivative employment. In most basin counties this sector has remained constant in numbers, thus increasing as a percentage of the total.

Retail trade, railroads, and government are responsible for much of today's service sector employment.

TABLE C

Employment by Gross Sectors, 1970

Sector	Number	Percent of Total
Agriculture	1,151	31.4
Forestry & Fisheries	2	0.1
Mining	118	3.2
Construction	178	4.9
Manufacturing	130	3.5
Services & Other	2,090	57.0
Total	3,669	100.0%*

*Does not total 100.0 due to rounding.

Agriculture in the basin is predominantly devoted to livestock and livestock products, with over 75% of the receipts coming from this source. The main land use is range; very little land is irrigated, even in the crop-producing areas. Only in Fergus County are crops a significant source of income.

BASIN ENERGY SOURCES

Musselshell County has been a source of coal since the early 1900's. This county contains 3,467 million tons of subbituminous reserves (Montana Energy Office). Communication with area residents attribute the dewatering of Half Breed Creek to coal development. As coal development increases in this vicinity, efforts should be directed at preventing future dewatering of area streams. Lesser coal deposits are found in Garfield County, and plans are underway for developing this resource.

Petroleum production and/or exploration continues in most of this basin's counties. Petroleum County is the dominant oil producer in the basin. Natural gas production continues in Golden Valley County with total production, as of 1970, listed at 498,599 million cubic feet (Report on Resources of Eastern Montana, 1972).

V. MONTANA WATER POLLUTION CONTROL PROGRAM

INTRODUCTION

Water quality management planning is part of a broad, comprehensive water pollution control program administered by the Water Quality Bureau of the Environmental Sciences Division of the Montana Department of Health and Environmental Sciences. Details of this program are described in annual reports of the bureau. Important elements of the state program are:

1. State and federal waste discharge permit programs.

2. Water quality standards.

3. Statewide monitoring and surveillance.

4. Facilities construction grants, plan review, operation and maintenance inspections, training and licensing of operators.

5. Public participation.

6. Enforcement.

STATE AND FEDERAL WASTE DISCHARGE PERMIT PROGRAMS

The present state program of issuing waste discharge permits is operated under the authority given by the Montana water pollution control law and the Montana Pollutant Discharge Elimination System (MPDES). At the present time, the U. S. Environmental Protection Agency (EPA) is also issuing waste discharge permits in the state of Montana to federal facilities and to discharges, from other than incorporated communities, on Indian reservations. The permits are being issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, the state of Montana applied for and received authority from EPA to issue NPDES permits in Montana. Section 402

of the FWPCAA of 1972 provides that states with adequate water pollution control programs may apply for and receive authority from EPA to issue discharge permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 legislative session to provide statutory authority for administration of the NPDES program in Montana. The Montana Department of Health and Environmental Sciences was given the authority to administer the waste discharge permit program on June 10, 1974. Waste discharge permits issued under the NPDES prior to the MPDES permit program will serve as MPDES permit until their date of expiration. All MPDES permits issued meet the minimum requirements of the EPA for NPDES permits.

The Federal Water Pollution Control Act Amendments of 1972 established the following time schedule for upgrading waste treatment facilities:

MUNICIPALITIES

1. Secondary treatment or any more stringent limitations necessary to meet water quality standards by July 1, 1977.
2. Best practical control technology by July 1, 1983.
3. No discharge of pollutants by 1985 (goal).

INDUSTRIES

1. Best practicable control technology by July 1, 1977.
2. Best available control technology by July 1, 1983.
3. No discharge of pollutants by 1985 (goal).

NATIONAL SECONDARY TREATMENT REQUIREMENTS (FWPCAA OF 1972)

Minimum five-day biochemical oxygen demand (BOD_5) reduction to 85 percent.

Minimum suspended solids reduction of 85 percent.

Maximum effluent BOD_5 of 30 mg/l on monthly average and 45 mg/l on weekly average.

Maximum effluent suspended solids of 30 mg/l on monthly average and 45 mg/l on weekly average.

Maximum effluent fecal coliform of 200 organisms/100 ml on monthly average and 400 organisms/100 ml on weekly average.

ph limits on effluent maintained between 6 and 9.

Self-monitoring of these parameters is required. The frequency of monitoring is based on the population served and the complexity of the treatment facility and is stated in the NPDES or MPDES permit. In addition, some municipal dischargers are limited for and required to monitor effluent oil and grease.

WATER TREATMENT PLANT TREATMENT REQUIREMENTS

There are no parameters specified by the FWPCAA of 1972 to be monitored for water treatment plant discharges. The following requirements are being placed on NPDES permits issued in Montana:

1. No change in operating procedures will be allowed that would result in a less desirable discharge.

2. As soon as practicable but no later than July 1, 1977:

Total suspended solids (TSS)	<45 mg/l weekly average <30 mg/l monthly average
Total dissolved aluminum	1.0 mg/l monthly average <1.5 mg/l grab sample
pH	Maintained between 6.0 and 9.0

INDUSTRIAL BEST PRACTICABLE CONTROL TECHNOLOGY REQUIREMENTS (FWPCAA OF 1972)

Industrial waste dischargers will be required to provide the best practicable control technology currently available in treatment of their waste discharges. The parameters will be limited and monitored, and the frequency of monitoring will vary with the different types of industries. The specific parameters to be limited and monitored and the frequency of monitoring are stated in the NPDES or MPDES permit.

AGRICULTURAL TREATMENT REQUIREMENTS

The Montana Pollutant Discharge Elimination System 16-2.14(10)-S14460 requires that the owner or operator of any point source discharging pollutants into state waters shall file an appropriate MPDES permit application. In

this rule, the term "point source" includes animal confinement facilities which is defined as a lot or facility used or capable of being used for the feeding or holding of animals. The definition does not include land used for the growing of crops or vegetation for animal feeding or in other words, a pasture situation.

Applications for those facilities which contained 1,000 or more animal units on any 30 days during the previous year must follow the processing procedure as outlined in the above rule but small animal confinement facilities are processed via a shortened procedure.

The waste discharge permits issued for animal confinement facilities will generally prohibit any discharge of pollutants unless rainfall in excess of the 10-year, 24-hour rainfall or equivalent moisture for that locale has been received.

Irrigation return flows will currently be subject to MPDES permit if there is a point source discharge through a man-made or man-maintained system from 3,000 or more irrigated acres. The parameters to be monitored and the frequency of monitoring will be stated on the discharge permit. A recent court ruling may require modification of this requirement.

WATER QUALITY STANDARDS

Water pollution control started in Montana in 1907 with passage of legislation designed to protect domestic water supplies. A more comprehensive law was passed in 1955 that dealt with control and protection of water for recreation, agriculture, and industry. The 1955 law also established a water pollution control council and charged it with the tasks of classifying all streams in the state according to their most beneficial uses and establishing water quality criteria for the streams. The 1955 law also involved upgrading the treatment of wastes going into the streams. Montana thus became one of the first states to have enforceable stream classifications.

In 1965, the U. S. Congress passed the Federal Water Quality Act which required that all states classify and

establish water quality criteria for their interstate streams by July 1, 1967. Montana revised its standards for both interstate and intrastate waters and required a higher degree of stream quality than before. Secondary treatment or the equivalent was required of municipal and industrial discharges. In October, 1972, the Federal Water Pollution Control Act Amendments were passed expanding the authority of the Environmental Protection Agency. Uniform water quality standards and enforcement procedures throughout the United States became the objective. Montana revised its water quality standards and adopted these revised standards on July 13, 1973. The new standards became effective in November, 1973.

Montana water quality standards serve as a functional tool in protecting water quality; however, a number of laws, statutes, and regulations complement the water quality standards and significantly assist in protecting water quality.

STATEWIDE MONITORING AND SURVEILLANCE PROGRAM

Prior to 1972, Montana had done little water quality monitoring due to inadequate funding. With increased appropriations provided by the 1971 legislature and the federal government, the state greatly increased its effort. Personnel were added to the staff, and laboratory capabilities were expanded. The present state monitoring program includes compliance monitoring of point sources of wastes including monitoring of municipal and industrial wastes, long-term baseline monitoring of streams, and a statewide program for determining the general quality of all significant surface waters.

The statewide inventory of water quality will identify areas with water quality problems and will provide basic data for water quality management and planning programs. Included in the monitoring is a statewide assessment of the trophic (pollution level) status of Montana's lakes, reservoirs, and ponds. This program is coordinated with the EPA National Eutrophication Survey.

FACILITIES CONSTRUCTION, OPERATION, AND MAINTENANCE

A minimum requirement of primary treatment for all domestic sewage was first adopted by the Montana Board of Health

in 1952. All of Montana's communities have met this requirement, and many of the communities are upgrading their facilities to secondary treatment or are in the process of constructing or planning secondary treatment systems. Since 1956, there has been a federal grant program to assist municipalities in the construction of sewage treatment facilities, including outfall and interceptor sewers. In 1971, the Montana state legislature appropriated $4,000,000 to aid municipalities in construction of these same facilities. The 1973 legislature appropriated $1,600,000 to reimburse municipalities that had proceeded with construction since July 1, 1966, without waiting for state grants. With passage of the Federal Water Pollution Control Act Amendments of 1972, 75 percent of eligible project costs are federally financed. Due to a shortage of federal grant funds, a priority system for allocation must be used. The state, under EPA guidance, establishes priorities for proposed waste treatment projects.

An important part of municipal sewage treatment is proper operation and maintenance of facilities after construction is completed. In an effort to improve operation and maintenance, the state has conducted an operators' school each year. During recent years, this school has had about 100 operators attending. In 1971, a grant was obtained from the federal government for employing two training instructors to establish training programs throughout the state. This activity is in addition to the annual school.

An operators certification program was established in 1968 following enactment of a law requiring certification of those responsible for the operation of sewage treatment or industrial waste treatment systems.

PUBLIC PARTICIPATION

Public participation in the water pollution control is an increasingly important aspect of the state program. Public hearings are held concerning proposed regulations, water quality management plans, and waste discharge permit applications. The state also has an environmental impact statement requirement. These statements are presented to the public for comment, and hearings are conducted on highly controversial issues.

The public also is kept informed by means of a water pollution control advisory council which has been established by law to assist the Water Quality Bureau in preparation of rules and regulations and dissemination

of information to interested groups. Similarly, public meetings are attended on request, and a quarterly newsletter is published by the Water Quality Bureau.

ENFORCEMENT

Montana's laws on water pollution basically state (1) it is unlawful to cause pollution or place materials in a location where they are likely to cause pollution of state waters, and (2) discharge of waste material into state waters without a permit from the Department of Health and Environmental Sciences. Two administrative rules have been adopted by the Board of Health and Environmental Sciences which are the chief elements in Montana's water pollution control program. Montana's water quality standards serve as the primary means for defining pollution, and the Montana Pollutant Discharge Elimination System rule provides the mechanism for authorizing and controlling point source discharges to state waters. Violators of the law, a rule, permit, or order could be subject to injunction, civil penalties up to $10,000 for each day of violation, or criminal penalties with fines not to exceed $25,000 per day of violation and/or imprisonment for not more than one year for an initial conviction and not more than $50,000 per day of violation and/or imprisonment for not more than two years for subsequent violations. Significant steps were taken in 1974 to establish a workable enforcement program, including increasing the legal staff and additional allocation of technical staff.

VI. SURFACE WATER RESOURCES

The Musselshell River emanates from the Castle Mountains in central Montana. The confluence of the north and south forks near Martinsdale forms the mainstem Musselshell River. This basin is divided into three subbasins: Upper, Lower and Flatwillow Creek Drainage. As the river flows eastward, its flow increases from such tributaries as American Fork Creek, Big Elk Creek, and Fish Creek. Except for Flatwillow Creek, flow contribution by tributaries east of Ryegate is negligible and most of the river's summer flow is provided by three major reservoirs (Appendix C). (A list of all reservoirs in this basin is found in Appendix C). The drainage area of the Musselshell Basin at Mosby is listed as 7,846 mi^2 (20,321 km^2); from Mosby the river continues flowing 30 miles (55.5 km) northward before its confluence with Fort Peck Reservoir.

Flow records from the Musselshell are almost continuous since 1940; some stations such as Harlowton have recorded flows since 1907. Data shows that a record runoff was recorded in June of 1967. June is typically the high water period on the Musselshell River (Table 2). Low flows occur in the months of July, August and September.

Due to artificial flow maintenance, the only 7-day, 10-year low flow data available are upstream of Martinsdale. These stations are the North Fork and South Fork which have a 7-day, 10-year low flow of 2.4 and 1.2 cfs, respectively. Musselshell River flow recording stations maintained by the U. S. Geological Survey are listed on Table 3 and tributary information is given in Table 4. Table 5 lists parameters that are measured as part of the National Stream Quality Accounting Network.

Figure 2. Schematic of the Musselshell River Basin.

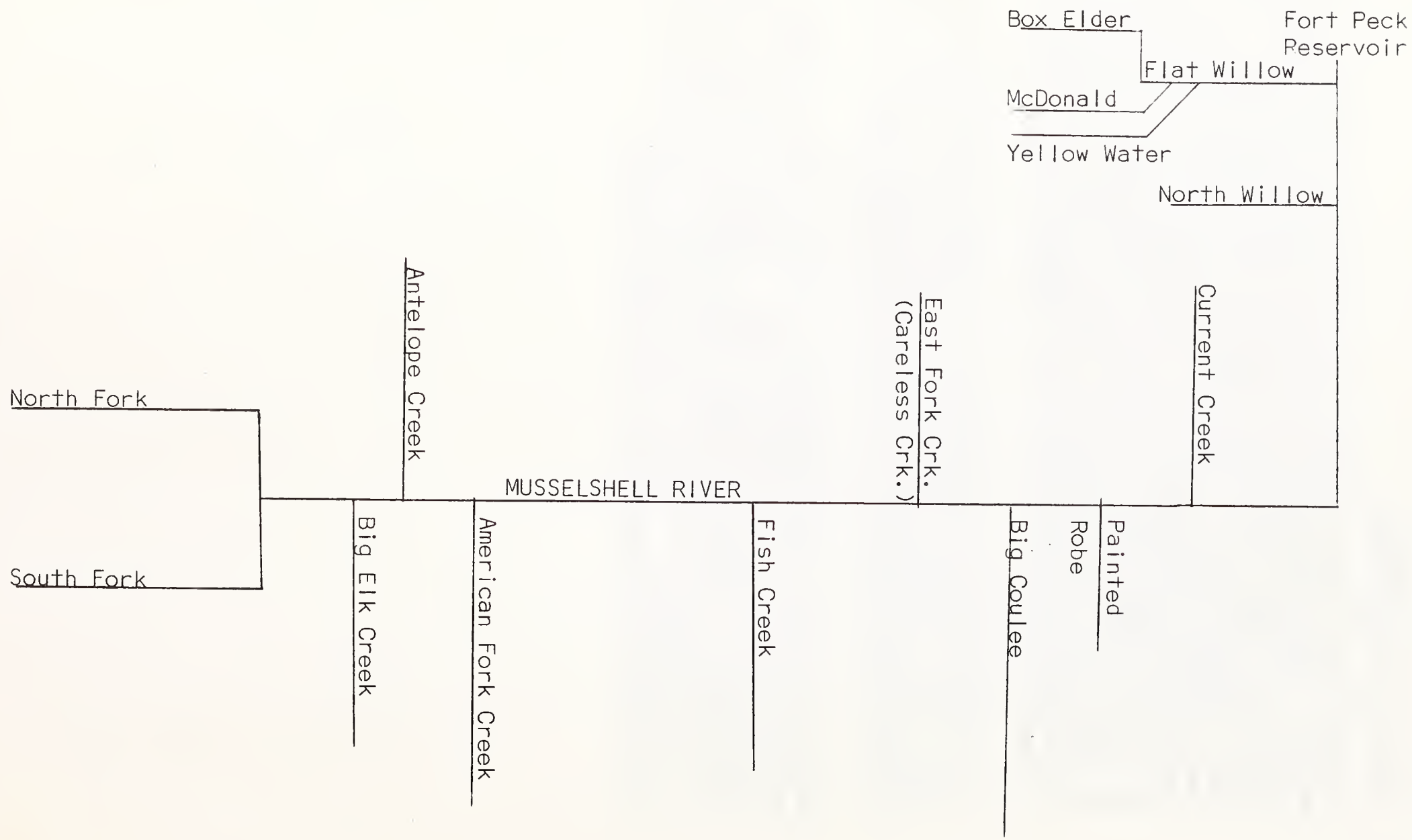


Table 2
Average Monthly Flow Data from the Musselshell River at Harlowton (cfs).

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly Average
1920	Ice	Ice	105	195	838	1010	447	40.3	43.5	Ice	Ice	Ice	382
1921	Ice	Ice	105	106	259	323	103	13.5	28.3	56.7	104	Ice	122
1922	Ice	Ice	108	243	486	866	105	21.1	35.3	47.4	66.5	Ice	219
1923	Ice	Ice	101	233	644	809	448	179	101	51.5	62.2	Ice	292
1924	Ice	Ice	71.2	267	737	272	56.3	7.1	11.8	159	98.3	Ice	186
1925	Ice	Ice	257	448	543	482	96.1	17.4	42.4	47.6	57.8	66.9	205
1926	93.2	61.6	77.5	345	715	137	65.4	16.5	50.2	93.4	94.8	83.5	153
1927	Ice	Ice	65.3	147	670	1470	223	139	120	80.1	76.2	Ice	332
1928	Ice	Ice	387	480	1140	297	240	56.6	60.8	121	173	171	312
1929	Ice	Ice	136	131	223	251	253	.25	4.5	83.5	78.1	Ice	128
1930	Ice	Ice	75.1	247	113	27.9	1.74	10.8	7.4	31.3	47.7	Ice	62
1964	55.5	48.4	54.6	78.5	244	762	173	113	36.0	45.3	74.0	69.5	132
1965	89.4	100	78.4	234	357	602	204	126	254	33.2	37.2	73.7	142
1966	74.2	79.1	152	123	347	161	143	880	39.6	191	131	105	137
1967	51.6	48.2	81.8	171	599	1842	343	142	90.8	47.3	68.4	61.0	295
1968	73.9	126	133	129	267	624	175	152	93.7	88.3	111	86.9	171
1969	63.2	76.8	266	531	155	185	207	105	39.5	98.8	109	54.3	158
1970	51.4	70	70	217	1650	1040	305	190	201	67.9	87.8	71.4	204
1971	70.6	124	96.3	235	437	270	145	95.6	102	91.3	75.2	91.0	153
1972	55.1	73.4	235	168	304	290	93.2	150	119	110	106	48.9	146
1973	41.3	45.4	66.2	55.9	38.7	86.3	35.3	22.2	30.4	93.8	94.7	47.0	54.7

Ref. Water Resources Data for Montana, Surface Water Records, U. S. Geological Survey.

Table 3

FLOW RECORDING STATIONS IN THE MUSSELSHELL RIVER MAINTAINED BY THE U.S.G.S.

STATION NO.	STATION NAME	LOCATION	DRAINAGE AREA	PERIOD OF RECORD	DISCHARGE MAX / MIN c.f.s.	
06115500	North Fork @ Delpine	10N 09E 22	31.4 mi^2 (81.3 km^2)	1940-Present	423	Apr 1950
					1.6	Aug 1941
06118500	South Fork nr Martinsdale	08N 11E 17	287 mi^2 (743 km^2)	1941-Present	1330	May 1967
					.1	Aug 1949
06120500	Harlowton	08N 15E 28	1125 mi^2 (2914 km^2)	1907-29, 1930-32, Apr-Aug 1933, Feb 1934-Present	4530	June 1938
					0	
06123500	Ryegate	06N 20E 03	1979 mi^2 (5126 km^2)	July 1946-Present	9500	June 1967
					0	
06126500	Roundup	08N 25E 22	4023 mi^2 (10,420 km^2)	1946-Present	9610	June 1967
					.60	May 1962
06127500	Musselshell	09N 29E 20	4568 mi^2 (11,831 km^2)	1928-32, 1945-Present	9850	June 1967
					0	
06130500	Mosby	14N 30E 11	7846 mi^2 (20,321 km^2)	Nov 1929, March 1930-Sept 1932, 1934-Present	18,000	June 1944
					0	

TABLE 4

MISCELLANEOUS FLOW RECORDS FROM THE MUSSELSHELL RIVER BASIN (USGS)

STATION	LOCATION	PERIOD OF RECORD	DATE	RECORDED MAXIMUM cfs	(m^3/sec)
Antelope Creek tributary	NE of Harlowton 10N 14E 08	1956 - 1972	3/18/72	2	(.056)
Antelope Creek tributary near Harlowton	NW OF Harlowton 10N 14E 22	1956 - 1972	3/18/72	est. 2	(.056)
Antelope Creek tributary No. 2 near Harlowton	N of Harlowton 08N 15E 10	1956 - 1972	5/10/72	est. 2	(.056)
Antelope Creek at Harlowton	Intersection of Highway 12 08N 15E 22	1950; 1954-1972	5/10/72	est. 5	(.14)
Current Creek	7 miles SW of Roundup 07N 25E 07	1958 - 1972	6/9/72	320	(8.96)
South Willow Creek tributary	4.5 miles N of Roundup 09N 25E 28	1962 - 1972	6/9/72	130	(3.64)
Musselshell River tributary	8 miles W of Musselshell 09N 28E 30	1963 - 1972	6/9/72	380	(10.64)
Butts Coulee	4 miles NE of Melstone 10N 31E 09	1963 - 1972	6/9/72	215	(6.02)
South Fork of Bear Creek	SE of Roy 18N 22E	1962 - 1972	7/19/72	75	(2.1)

Table 5

MUSSELSHELL RIVER AT MOSBY - DATA COLLECTION PROGRAM - NATIONAL STREAM QUALITY ACCOUNTING NETWORK WATER-QUALITY, U.S.G.S.

Station No.	Name	Location
06130500	Musselshell River at Mosby	14N 30E 11BB

Parameter List

Daily -	Temperature, Specific Conductance (S.C.)
Monthly -	HCO_3, CO_3, Ca, Mg, F, Na, K, Dissolved Solids, SiO_3, Cl, SO_4, Total P, Total NO_3-NO_2, Total Kjeldahl N
Physical -	Turbidity, pH, DO, Suspended Sediment
Biological -	Fecal Coliform, Fecal Streptococci, Phytoplankton

Quarterly

Chemical -	TOC, Total and Dissolved Metals: As, Cd, Ch, Ca, Cu, Fe, Pb, Mn, Hg, Se, Zn
Biological -	Periphyton, Chlorophyll

REFERENCE: Water-Resources Investigations of the U. S. Geological Survey in the Northern Great Plains Coal Region of Eastern Montana, 1974-75.

VII. WATER POLLUTION POINT SOURCES

MUNICIPAL FACILITIES

Eight basin communities have lagoons ranging in size from 21.5 acres to one acre. Harlowton and Winnett continually discharge, while Lavina periodically discharges. Characteristics of basin wastewaters are listed in Table 6.

LOCATION	PERMIT NO.	RECEIVING WATERS
Broadview Yellowstone County 04N 23E 14	MT-0020770	Dry Coulee
Grass Range Fergus County 15N 23E 28	None	No discharge. Adjacent to South Fork McDonald Creek
Winnett Petroleum County 14N 26E 5	MT-0020702	McDonald Creek
Lavina Golden Valley County 06N 22E 11	None	Periodically discharges to Musselshell River
Ryegate Golden Valley County 06N 20E 5	MT-0020451	No discharge Musselshell River
Roundup Musselshell County 06N 25E 13	None	No discharge Musselshell River
Melstone Musselshell County 10N 31E 32	MT-0020427	No discharge Musselshell River
Harlowton Wheatland County 08N 15E 22	MT-0020354	Musselshell River via small creek

A description of the preceding facilities is found on page 73.

INDUSTRIAL FACILITIES

Three industrial facilities are located in this basin. The jet fuel refinery at Mosby has no discharge; consequently, no permit has been

Table 6
Water Quality Data from Point Source Discharges in the Musselshell Basin

Station	Date	Flow (GPM)	Temp (°C)	pH	DO	BOD	F.C.	Turb (JTU)	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	F	CDS
MUNICIPALITIES:																							
Harlowton Effluent 07N 15E 22	9/13/74	250	12.0	7.1	0	---	7800	80	58	1909	321	466	7.1	99	53	310	--	391	0	692	28	--	1582
Harlowton Influent 07N 15E 22	9/13/74	---	14.0	7.1	1.0	---	TNTC	15	58	2315	430	440	7.1	105	43	400	--	525	0	703	40	--	1818
Winnett Effluent 14N 26E 05	9/12/74	18.7	----	8.0	5.5	46	1080	13	28	3900	388	1140	7.1	434	13	570	--	473	0	1841	46	--	3380
Winnett Influent 14N 26E 05	9/12/74	---	----	7.5	2.4	---	TNTC	12	64	3820	361	1178	8.0	215	156	425	--	440	0	1595	44	--	2891
INDUSTRIAL:																							
Milwaukee Railroad Effluent 07N 15E 23	9/13/74	12.5	----	7.6	---	---	----	21	28	1776	538	339	7.6	61	45	340	--	656	0	502	1.7	--	1606
	(3/27/74)	COD 197, Total Oil and Grease 16 mg/l, Total Phenol 0.034																					
Jet Fuel Refinery Mosby		No Discharge																					

Station	Date	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As
MUNICIPALITIES:									
Harlowton Effluent 07N 15E 22	9/13/74	6.2	0.0	8.9	0.06	0.05	-----	----	0.005
Harlowton Influent 07N 15E 22	9/13/74	8.3	0.01	3.1	3.2	0.09	0.04	0.09	0.004
Winnett Effluent 14N 26E 05	9/12/74	7.3	0.01	2.1	0.48	0.14	----	0.02	0.002
Winnett Influent 14N 26E 05	9/12/74	5.4	0.05	16.0	----	0.37	0.013	0.11	0.005
INDUSTRIAL:									
Milwaukee Railroad Effluent 07N 15E 23	9/13/74	8.0	0.07	0.12	1.4	0.76	-----	0.04	0.002
Jet Fuel Refinery Mosby									

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.
Reference: Montana Water Quality Bureau.

issued. Milwaukee Railroad facilities at Harlowton are used for servicing and maintenance of diesel locomotives. Their wastewater is treated by means of a LATTA oil separator and two retention ponds. The J. Burns Brown discharge emanates from a well. This discharge flows to the Musselshell River via Mud Creek.

LOCATION	PERMIT NO.	RECEIVING WATERS
Milwaukee Railroad Harlowton	MT-0000400	Musselshell River 07N15E23
J. Burns Brown Shawmut	MT-0022691	Mud Creek 07N17E - Wheatland
Jet Fuel Refinery Mosby	No discharge	Musselshell River 14N31E6 - Garfield

AGRICULTURAL FACILITIES

As of February 25, 1975, five agricultural permits have been issued and one application pending. There are, at a minimum, six more agricultural facilities that have not applied for discharge permits. The following is a list of the known agricultural dischargers. Solid wastes from these operations will be placed on adjacent agricultural lands.

PERMITTEE/LOCATION	PERMIT NO.	ANIMALS CONFINED
Joseph A. Pease Melstone, Montana 10N31E31C	F-29-B	1,000 (beef)
Faunco, Inc. Roundup, Montana 08N26E08	F-31-B	12,000 (beef)
Joseph Spear Estate Roundup, Montana 08N25E36A	MT-0029019	350 (swine)
Heiken Land & Livestock Co. Lavina, Montana 05N22E09CC	MT-0023469	1,500 (beef)
Madox Land & Cattle Company Broadview, Montana 05N23E19C	MT-0022764	2,500 (beef)
Ross Ranch Judith Gap, Montana 10N18E20AC	Permit Denied	500 (swine)

Defunct mining activities (in the upper basin) and present oil exploration (in the lower basin) have caused no known change in water quality.

Miscellaneous gravel removal operations occur in this basin. One such operation near Harlowton is located at stream side and has severe erosional potential. Attempts to locate the owner(s) have been futile.

VIII. WATER POLLUTION NONPOINT SOURCES

Ecological impact of nonpoint sources depends on intensity and yield factors as well as the seasonal distribution of their contribution. Since overland flow and stream flow are the major transport agents for the nonpoint sources, knowledge of time changes in concentrations and flow are essential for calculations of yield rates. Comparison of nonpoint sources based solely on concentration units is difficult because of the flow-dependent, intermittent nature of the sources. A better method of comparison is the use of area yield rates. A commonly used yield rate is the quantity of characteristic (e.g., sediment) per unit of drainage area per unit of rainfall or runoff (Loehr, 1974). The importance of yield rates is illustrated in the following basin data:

COUNTY	SEDIMENT YIELD TONS/SQ MILE/YEAR	% LAND PUBLICLY OWNED	ACRES IRRIGATED	TOTAL COUNTY SQ. MILES
Wheatland	40	23	32,000	1,425
Golden Valley	100	11	5,100	1,180
Musselshell	200	17	7,900	1,887
Petroleum	500	44	14,800	1,672

Data: Bureau of Reclamation

Rangeland is the dominant basin land use. From the preceding sediment yield rates, one may conclude that erosion due to land abuse may be a dominant nonpoint pollution source. It is also apparent that care of public lands (state and federal) such as those in Petroleum County has been neglected. Some erosion problems in the basin are due to natural geologic process (BLM letter, April 2, 1976). The BLM rated the federal lands as: 79% no erosion to slight accelerated erosion, 20% in the slight to moderate and moderate to severe in the remaining 1%. Figures 3, 4, 5 and 6 show the downstream accrual of sediment and tons of sodium and sulfate that are carried by the Musselshell River.

Nonpoint sources in the Musselshell basin fall into three broad categories: logging, agricultural, and natural. In this basin, urbanization is not a problem.

Sediment is a pollutant common to all of the basin's nonpoint sources. Heavy silt loads decrease or destroy a stream's natural productivity and aesthetic value. Sediment loads are often associated with higher water temperatures, increased turbidities, low oxygen levels, increased nutrient loads, increased salt loads and ultimate destruction of the aquatic biota.

Logging occurs in the Bull Mountains near Roundup. However, due to the scarcity of perennial streams in this region, logging will have little effect on water quality. Increased erosion will probably be noticeable

in areas with steep topography. The area primarily affected will be the streams adjacent to sawmills. At the present time, one sawmill is piling and burning their slash on the banks of Half Breed Creek. This sawmill waste immediately enters the Musselshell River. Operators of the sawmill have agreed to discontinue this practice. Future checks will be conducted for their compliance.

Agricultural practices that cause sediment loads are irrigation, overgrazing, extensive monoculture, and removal of brush and trees from stream banks. Other agricultural pollutants may arise from concentrated livestock feed operations, sprays, and fertilizers. Due to the poor cattle market, many basin feedlots are not currently in operation; thus, there are few water quality problems arising from feedlot operations. However, due to the proximity of several feedlots to the Musselshell River, upon resuming operation, these feedlots, if not controlled, may impact the stream.

Approximately 60,000 acres are irrigated throughout the basin. Factors affecting a stream used for irrigation are temperature increases, sediment and salt loads, and dewatering. The preceding changes are harmful in sustaining the aquatic biota and the water quality. The quality of irrigation return flow is affected by a multitude of factors: evaporation, transpiration, ion exchange, erosion, soil composition, types of crops, fertilizers, and precipitation--amount and rate. Irrigation return waters may be improved by settling basins or by preventing excessive amounts of water reaching the irrigated plots. This would require careful water control. Present irrigation systems employed in this basin probably could be much improved in efficiency. Irrigation return flow effects may further be alleviated by encouraging ground cover and prevention of stream bank defoliation.

Extensive monoculture and overgrazing result in removal of protective vegetation. This loss of vegetation results in greater soil erosion, which in turn results in heavier stream sediment loads. As noted by Loehr (1974), wide ranges of phosphorus values are reported from runoff waters. These ranges are variable due to erosion; when erosion is controlled, the total phosphorus load should decline.

Saline seep is a nonpoint source in this basin which needs further investigation. The magnitude of the problem is not completely documented. However, the potential exists for degrading water quality and water supplies. Defining areas of saline waters is currently in progress and should be expanded. Streams reflecting saline problems are: Big Coulee, Mud Creek, Painted Robe, and North Willow Creeks (Table 10). A more thorough discussion of this problem is presented by Bahls and Miller (1973).

Stumm (1970) points out that nonpoint source control is basically a conflict between resource exploitation and protection of natural waters.

Stumm breaks the conflict into two groups: reducing ecological stability and promoting ecological stability. Stumm (1970) further states that exploitation of adjacent soil occurs by crop growing, seeding, weeds and grazing, fertilizing, irrigating, deforestation, converting grassland into cropland, applying herbicides and pesticides. These effects may be mitigated by conservative land management through reforestation, restricting monoculture productivity, zoning (maintaining zones adjacent to open waters which are kept free of fertilizers and of low net productivity), controlling erosion, and using detritus agriculture. An active program of conservative land management would be of undeniable value to the water quality of the Musselshell River.

The sediment load carried by Careless Creek is a problem. Contributions of more than 30 tons sediment/day to the Musselshell River is excessive and should be corrected. Communication with local residents indicates that the Musselshell River is definitely "dirtier" downstream of Careless Creek. Other personal communications indicated that (as recently as the late 1960's) the Musselshell River used to be clear at Musselshell. This clarity is no longer evident. The fact that changes have occurred is further indicated in data comparisons of 1966-68 and 1974 (Tables 14 and 15 and Figure 6). Sediment loads at Mosby are presented on Tables 16, 17, 18 and 19. Typically June has the highest flows and greatest suspended sediment load. Ancillary high flows and sediment yield also occur during spring months.

Figure 4. Suspended Sediment at Selected Stations on the Musselshell River.

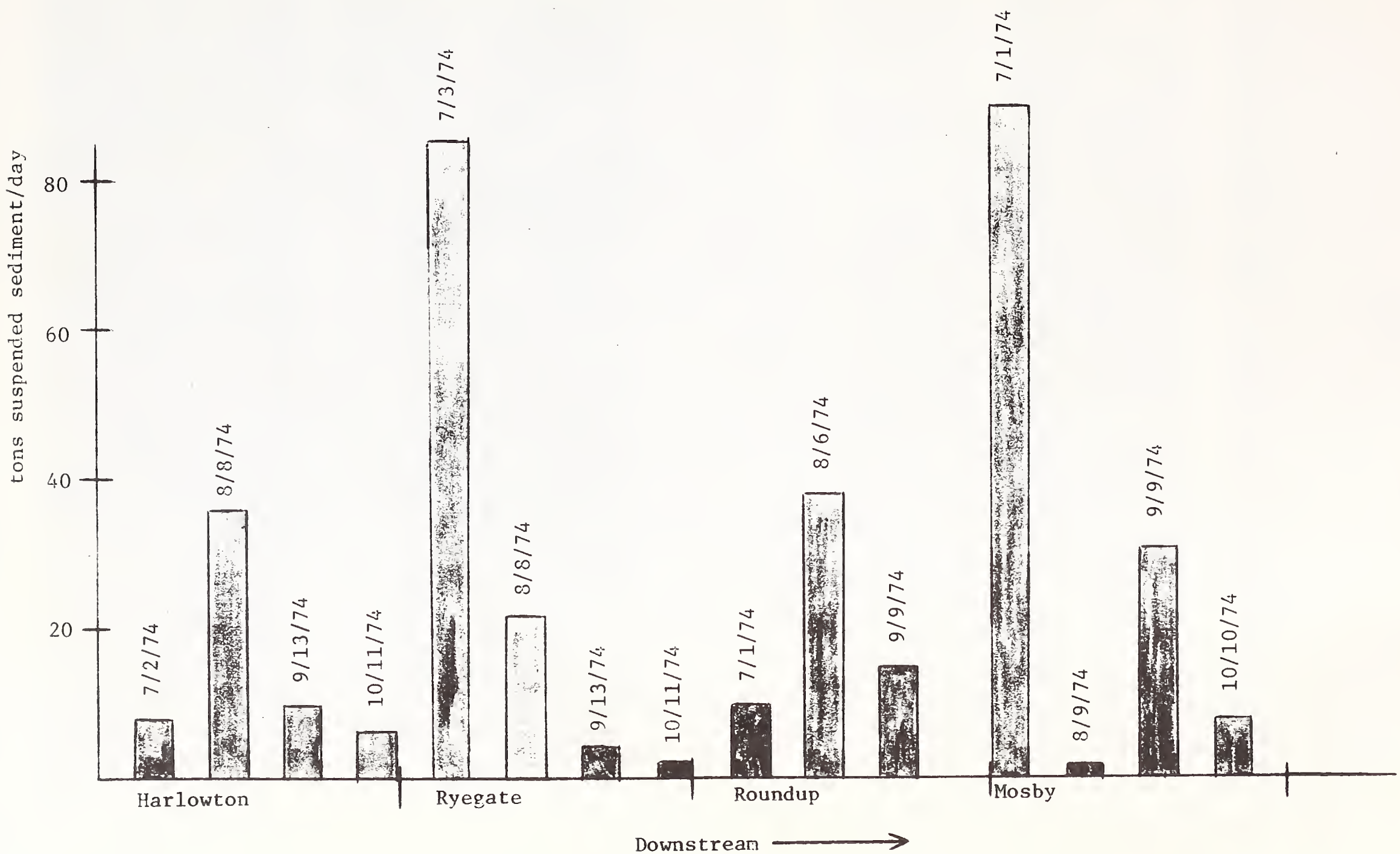


Figure 3. Accrual of Sodium During Summer Months at Selected Stations in the Musselshell River.

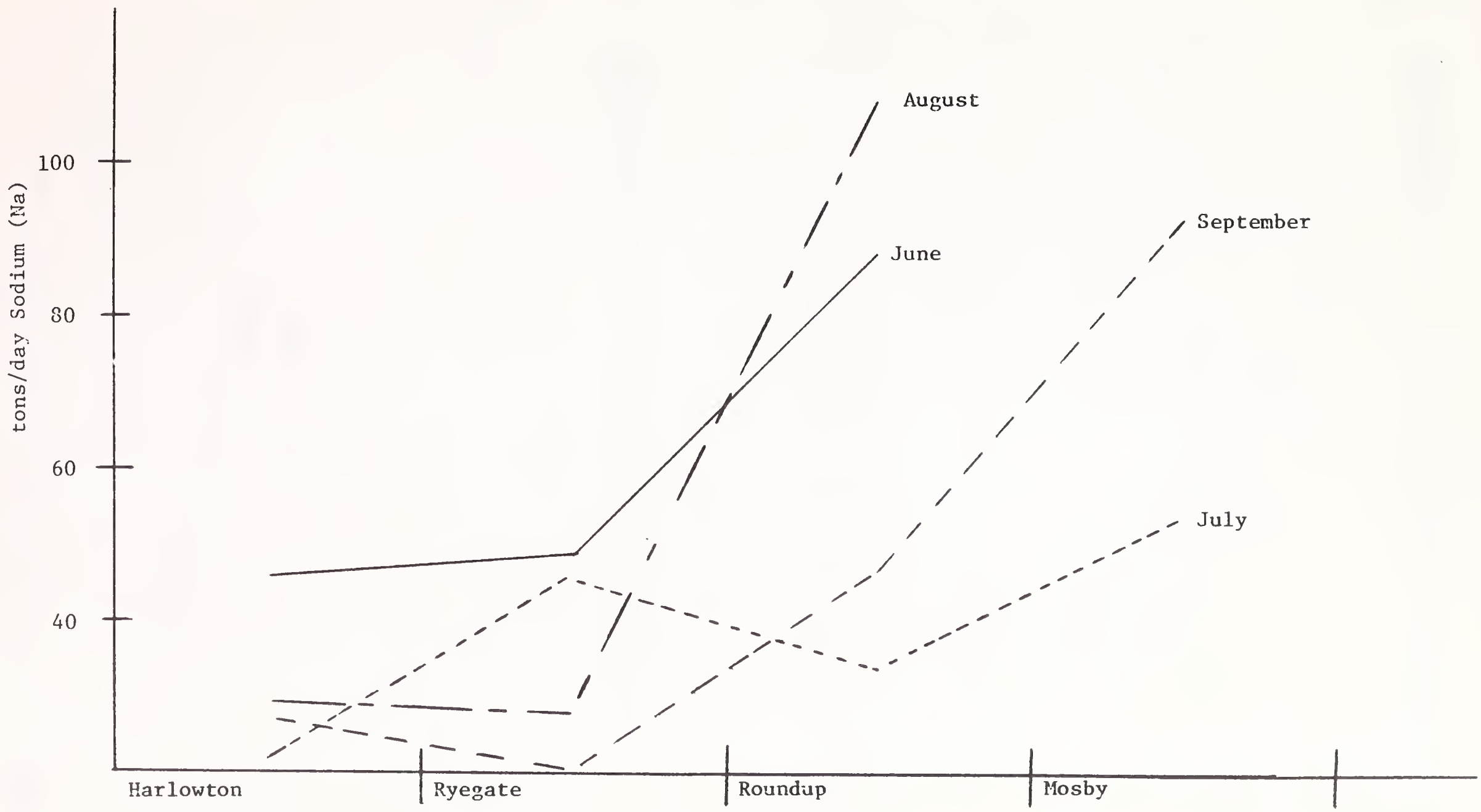


Figure 5. Flow versus Sodium Concentrations Showing Downstream Increases on the Musselshell River, Locations as Noted.

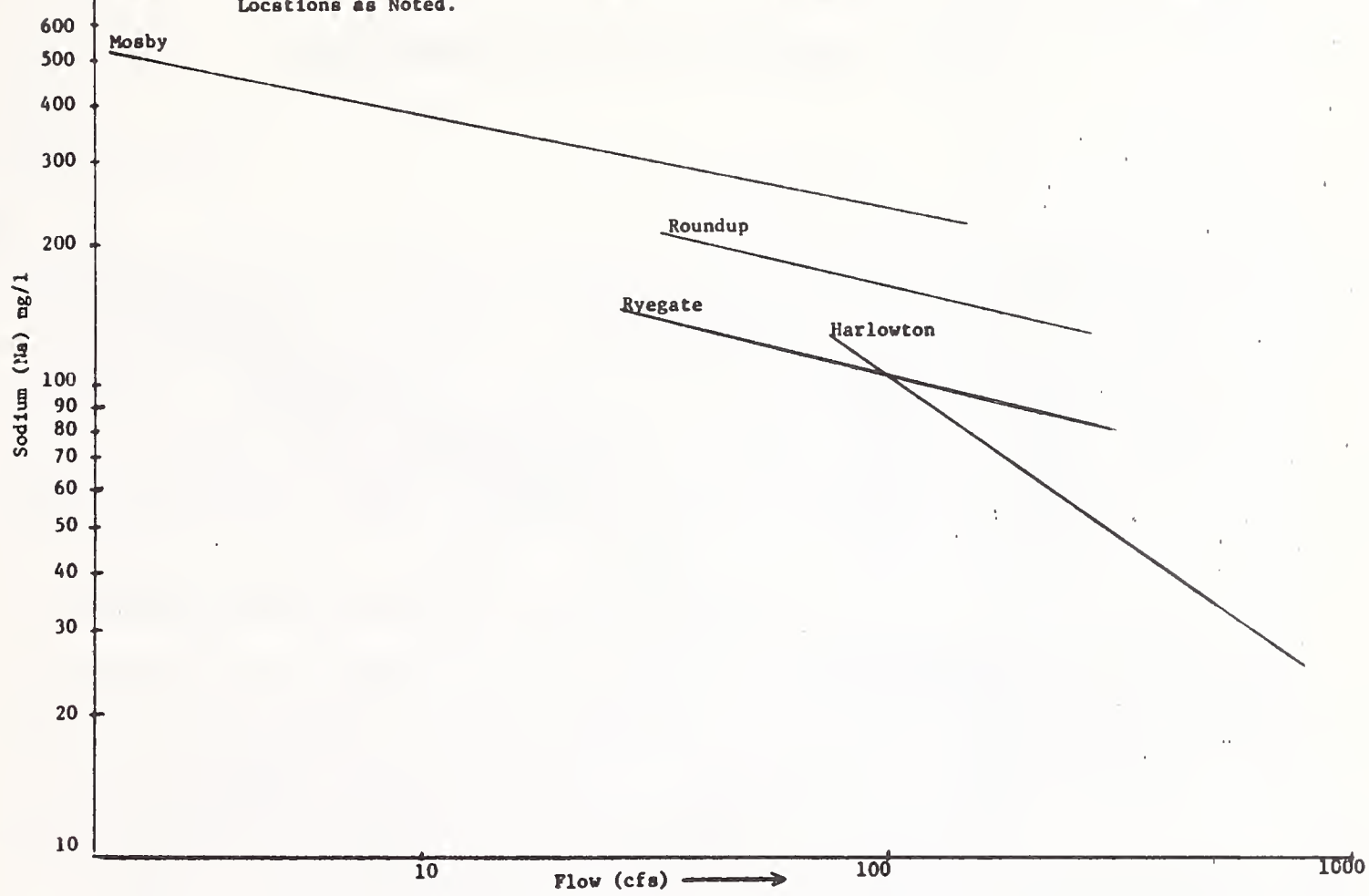


Figure 6. Flow versus Sulfate Concentrations Showing Downstream Increases on the Musselshell River, Stations as Noted.

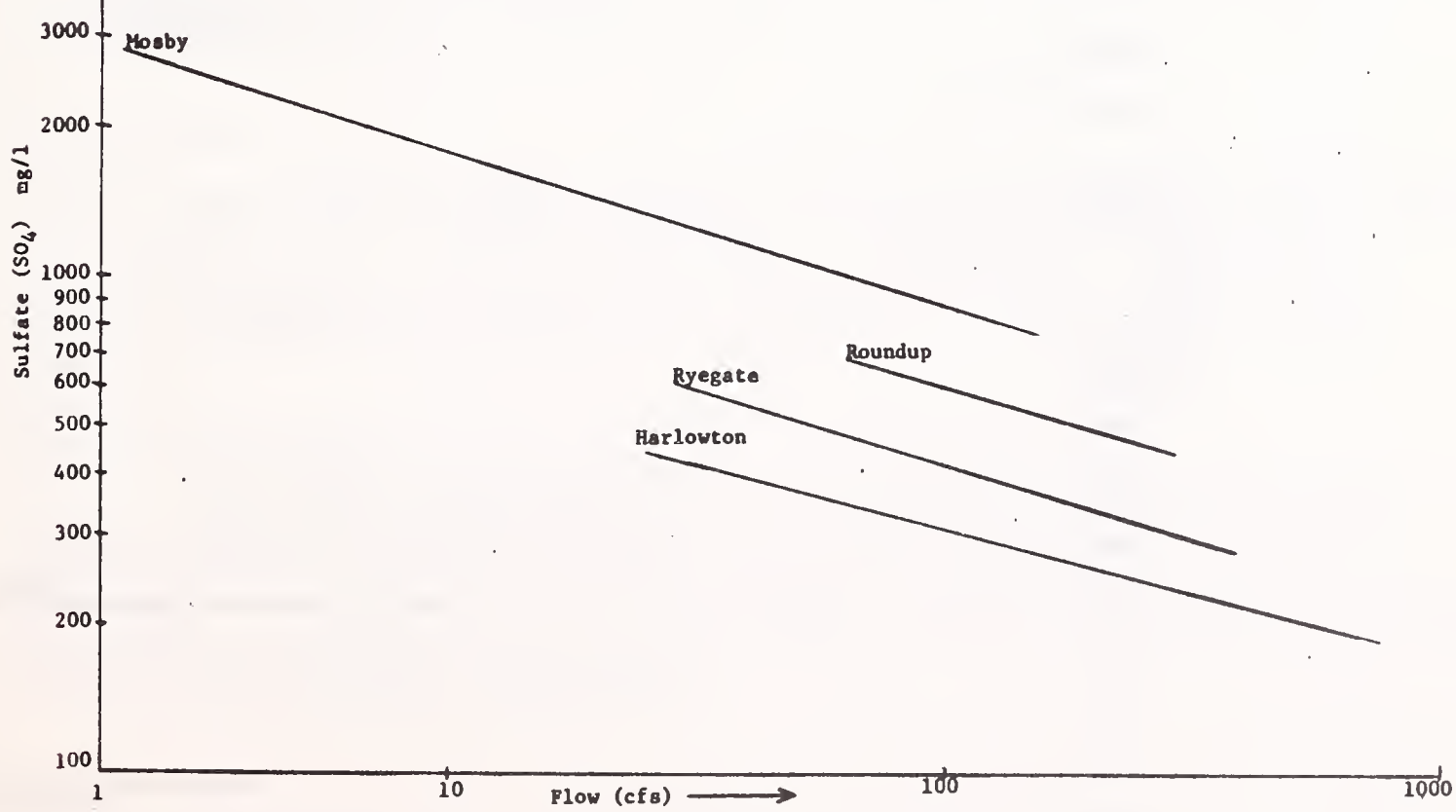


Figure 7. Sodium Adsorption Depicting Downstream Increases

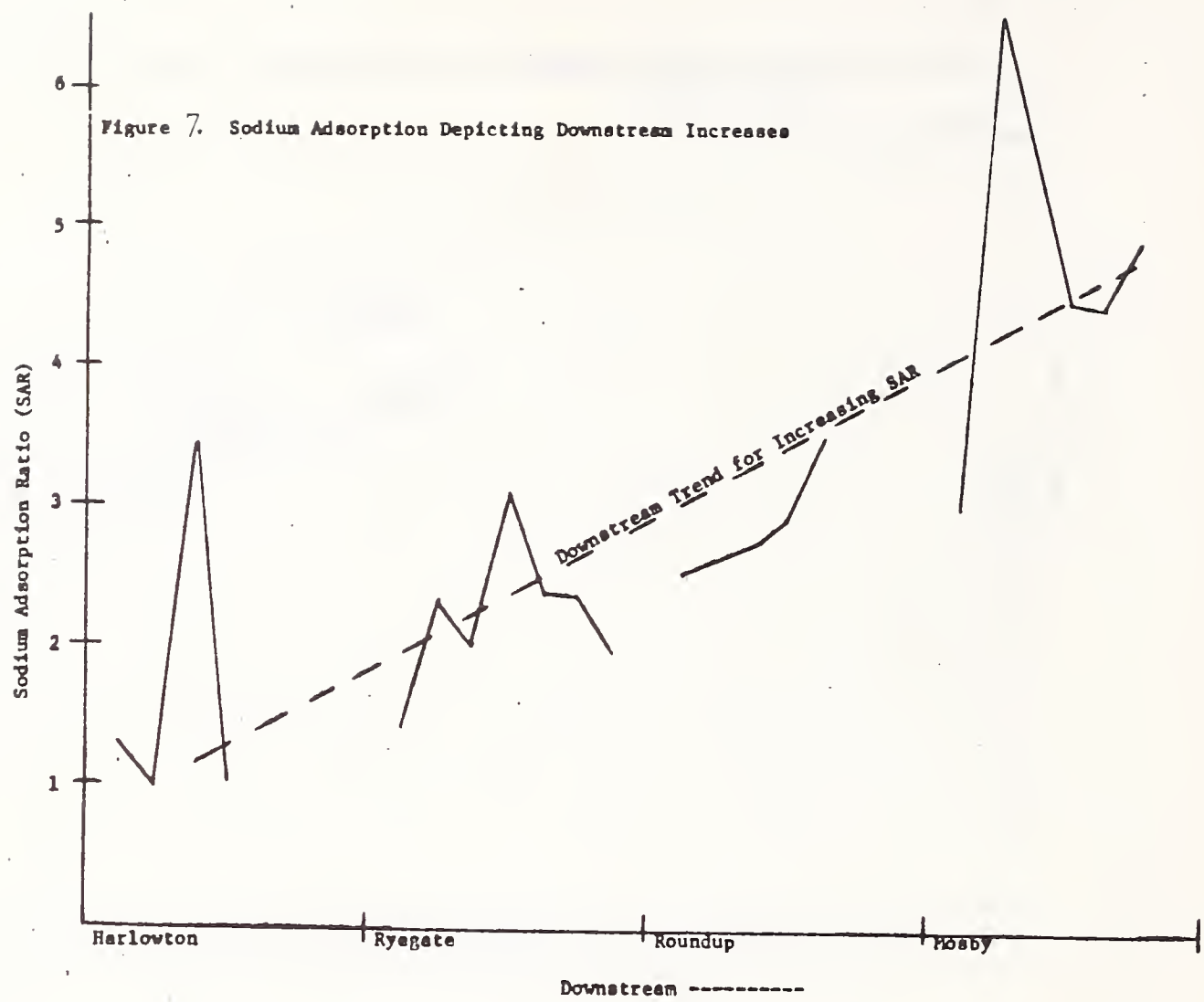
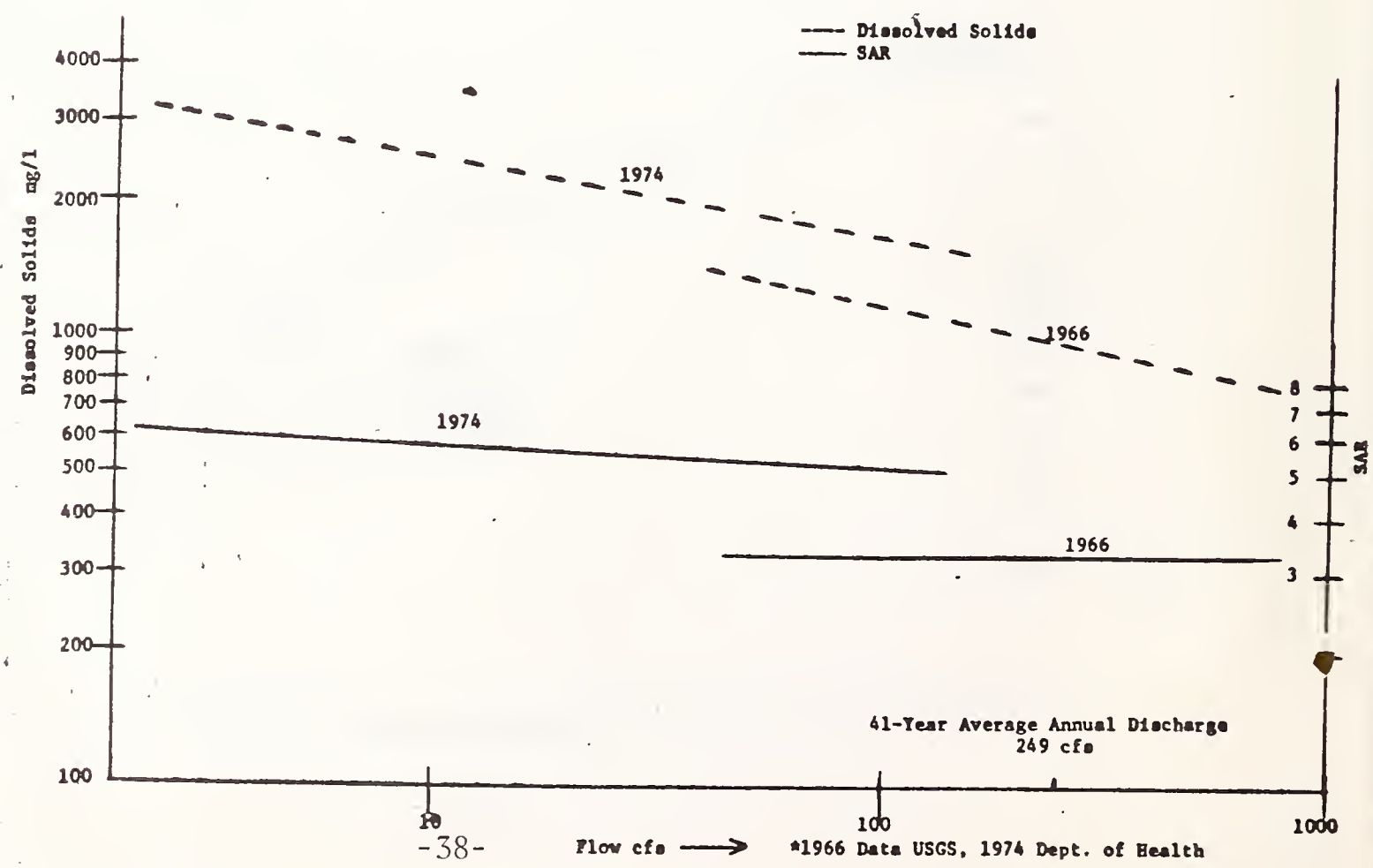


Figure 8. Depicting Changes in SAR* and Dissolved Solids in Musselshell River at Mosby.



IX. WATER QUALITY

Roundup is designated the dividing line for the upper and lower Musselshell sub-basins. For water quality purposes this dividing line would be best placed near Shawmut. From Shawmut downstream, the river becomes more turbid, warmer, more saline, and no longer supports a cold water fishery. The major feeder stream in the upper basin is American Fork Creek. Smaller feeder streams are Big Elk, Antelope, Fish, Mud, Big Coulee, Careless, Little Careless, and Painted Robe Creeks. The water quality in these streams ranges from high quality to saline.

North and South Forks of the Musselshell

Individually, the North and South Forks of the Musselshell River are waters of fine quality; both being hard, calcium-bicarbonate streams. Nitrate and phosphate concentrations tended to increase during the peak of the irrigation season (Table 7). Nutrient concentrations are sufficient to cause seasonal stream enrichment.

A periphyton analysis (Table 8) upstream of Harlowton substantiates the effect of the nutrients. This analysis indicates the river had moderate nutrient enrichment, with moderate salinity. The remaining flora exhibited average diversity for a cool flowing stream.

On the North Fork, a zinc concentration of 1.3 mg/l was measured (Table 7). This is the only abnormal metal parameter recorded. All other measured parameters indicate waters of high quality.

Montana Fish and Game surveys (1970) concluded the North and South Forks to be high quality waters sustaining a cold water fishery. In protecting this resource, considerations must be given to the prevention of dewatering and loss of vegetation on stream banks.

Big Elk Creek

Big Elk Creek emanates from the Crazy Mountains and enters the Musselshell River near Two Dot. In this hard, calcium-bicarbonate stream water quality was good (Table 10). Periphyton analysis indicates this stream has slight enrichment, but the flora is typical of a cool flowing stream (Table 28).

American Fork Creek

American Fork Creek near Harlowton is a calcium-bicarbonate water displaying moderate enrichment (Table 9). This stream supports a viable cutthroat trout fishery, which is in danger of destruction due to dewatering. Fecal coliforms were the only measured parameter in violation of state water quality regulations.

Musselshell at Harlowton

Water quality in the Musselshell was surveyed upstream and downstream of Harlowton. The stream's flora reflected a moderate salinity and nutrient enrichment. This condition is probably a result of irrigation water. All measured water quality parameters, except for fecal coliforms (Table 8) were in compliance with state regulations. A potential problem exists at Harlowton due to oil saturated grounds near the Milwaukee Railroads repair shop. Also a gravel operation east of Harlowton has dumped spoils into the river. Ownership of this operation has not been determined.

Antelope Creek

Antelope Creek is an alkaline sodium-sulfate stream. Due to the high dissolved solids concentration in this stream usage of this water must be done under careful management. Fecal coliforms were in violation of state water quality regulations (Table 10).

Mud Creek

Mud Creek, located near Shawmut, has high specific conductance (S.C.) suspended solids, and sulfates (SO_4) (Table 10). Although this analysis is incomplete, it indicates these waters have little practical use. Mud Creek's possible degradation effects on the Musselshell River warrant further investigation.

The Musselshell River at Ryegate

The Musselshell River at Ryegate is a different type stream than the water at Harlowton. The river changes to a sodium-sulfate type water with increased sediment loads, turbidity, and higher specific conductance. These water quality changes are partially attributed to natural terrain and irrigation waters. Figures 4, 5 and 6 depict some of the changes that occur near Ryegate. Further investigations are recommended to fully differentiate the causes of these water quality changes.

Fish Creek

Fish Creek is a very hard, sodium-bicarbonate stream (Table 10). Sediment load of this stream is 1.4 tons/day; and the stream degrades the Musselshell River. It is not known if this sediment load is natural or culturally induced.

Careless Creek

Flow of this stream is irrigation "make-up" water discharged from Dead man's Basin. The waters are sodium-sulfate waters of extreme hardness (Table 12). Nutrient concentrations are high--especially during July. These nutrient values may be related to Deadman's Basin's discharge. Recorded sediment load during the sampling periods of June, July, and August was 28.7, 31.9, 37.8 tons/day, respectively. This high sediment

Table 7

Water Quality Data from the South Fork and North Fork of the Musselshell River.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
South Fork	6/16/74	200 E	11	8.0	----	---	---	----	---	237	92	99	8.0	28	7.1	7.6	1.3	112	0
08N 11E 11CA	7/2/74	118	12.5	6.7	----	---	0	3.5	8.0	414	---	157	---	---	----	-----	----	---	--
	8/8/74	17.5	16.0	8.3	9.0	6.4	28	12	8.0	566	180	235	8.3	58	22	23	1.5	219	0
	1/7/75	85 E	1	---	13.7	5.3	107	1.5	4.0	637	194	260	7.9	69	21	32	----	237	0
	2/17/75	Ice	1	---	11.1	---	---	1.5	4.0	563	178	236	8.0	57	23	30	1.4	217	0
North Fork	6/16/74	30 E	----	8.4	----	---	---	----	---	576	199	287	8.4	69	28	11.5	2.2	227	7
08N 11E 01BC	7/2/74	25	12.5	7.2	8.9	4.6	20	2.3	1.0	872	220	402	7.2	--	--	----	----	---	--
	8/8/74	13	16.0	8.4	8.9	5.3	22	6	1.0	679	221	355	8.5	80	38	26.5	24.0	245	12
	1/7/75	95 E	0	---	11.7	4.0	1	2.3	4.0	606	217	304	7.7	72	30	10	----	265	0
	2/17/75	Ice	1	---	10.6	---	---	2.8	2.0	557	213	284	8.0	40	45	15	1.8	260	0

E - Estimate

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
South Fork	6/16/74	29	0.7	----	186	0.3	0.07	0.09	2.07	0.10	0.01	0.02	0.008	<.001
08N 11E 11CA	7/2/74	---	---	----	-----	---	----	----	0.33	0.06	<.01	<.01	<.001	<.001
	8/8/74	99	2.0	0.32	426	0.7	1.4	0.09	0.27	0.03	0.01	0.02	<.001	<.001
	1/7/75	123	5.2	----	487	0.9	0.26	0.03	0.18	0.04	<.01	<.01	<.001	<.001
	2/17/75	108	4.8	0.26	441.4	0.9	0.53	----	----	----	<.01	<.01	<.001	<.001
North Fork	6/16/74	115	1.7	----	461.6	0.3	0	0.06	0.24	0.06	0.01	0.01	0.005	<.001
08N 11E 01BC	7/2/74	---	---	----	-----	---	----	----	0.40	0.06	<.01	1.3	<.001	<.001
	8/8/74	221	0.3	0.30	650.7	0.6	3.9	0.34	0.14	<.01	<.01	<.01	0.002	<.001
	1/7/75	108	2.2	----	487.5	0.2	0.97	----	0.14	0.03	<.01	<.01	<.001	<.001
	2/17/75	99	2.0	0.32	464.1	0.4	1.2	0.09	----	----	<.01	0.02	0.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau

Table 8

Water Quality Data from the Musselshell River Upstream and Downstream of Harlowton.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Harlowton Upstream	6/14/74	750	18	8.0	9.4	---	---	43	100	475	142	198	8.0	49	18.6	23	2.1	174	0
08N 15E 22CD	7/2/74	210	15	7.5	8.2	5.0	100	9	14	743	195	305	8.4	54	41	53	3.0	216	10
	8/8/74	335	20	8.1	8.5	5.9	970	13	42	679	180	295	8.1	63	34	38	3.5	219	0
	9/13/74	84	6	7.9	10.7	3.8	---	2	36	1192	235	372	7.6	87	38	150	---	287	0
	10/11/74	387	8	---	9.3	1.8	44	--	6	1047	235	230	8.2	92	0	36	---	287	0
	11/21/74	184	1.0	8.1	15.1	8.1	0	--	---	----	---	---	---	---	--	---	---	---	--
	1/7/75	258	0.0	---	13.2	5.1	0	2.1	6	958	240	415	7.6	99	41	61	---	293	0
	2/17/75	Ice	1.0	---	9.8	---	---	1.5	2	882	226	386	7.8	49	64	57	1.9	276	0
Harlowton Downstream	8/7/74	210	21.0	8.4	8.9	6.3	350	18	66	687	180	278	8.3	64	29	40	3.4	220	0
07N 15E 23CC	11/21/74	184	1.0	8.1	15.1	8.1	0	--	16	995	237	416	8.6	101	40	65	---	275	7

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Harlowton Upstream	6/14/74	107	3.3	0.28	377	0.7	0.16	0.10	2.6	0.14	<.01	0.03	<.001	<.001
08N 15E 22CD	7/2/74	214	4.5	----	597	1.3	0.08	0.06	0.38	0.05	<.01	0.06	<.001	<.001
	8/8/74	189	2.7	0.23	550	1.0	0.40	0.06	0.54	0.12	0.01	<.01	<.001	<.001
	9/13/74	413	7.8	----	983	3.4	0.05	0.31	0.23	0.04	0.012	0.014	<.001	<.001
	10/11/74	745	5.0	----	1165.1	1.0	0.13	0.06	----	----	-----	-----	-----	-----
	11/21/74	---	---	----	------	---	----	----	----	----	-----	-----	-----	-----
	1/7/75	290	5.5	----	790.2	1.3	1.06	----	0.14	0.02	<.01	<.01	<.001	<.001
	2/17/75	272	4.5	0.29	726.4	1.3	1.3	0.09	----	0.01	<.01	<.01	<.001	<.001
Harlowton Downstream	8/7/74	182	3.7	0.26	542.1	1.0	0.26	0.06	----	----	-----	-----	-----	-----
07N 15E 23CC	11/21/74	307	8.0	----	803.1	1.4	0.27	0.03	0.08	0.04	0.01	0.01	-----	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Table 9

Water Quality Data from American Fork Creek.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
American Fork Creek	7/2/74	27	13.8	7.5	7.7	4.5	14	2	71	362	96	138	8.1	22	19.9	15	1.7	117	0
07N 15E 12CC	8/8/74	0.67	19.0	8.1	----	---	1170	2	4	448	222	200	8.4	71	5.3	20	1.6	267	2
	9/13/74	5.2	8.0	7.9	9.8	2.2	----	1	10	502	223	194	7.9	47	18.7	16	---	272	0
	10/11/74	6.8	8.5	---	8.7	1.1	0	-	4	452	216	200	8.1	55	15.2	21.6	---	264	0
	11/21/74	7.1	2.1	6.9	15.2	5.7	3	-	20	453	201	200	8.3	53	16.8	23	---	245	0
	1/7/75	9.0 E	0.5	---	11.7	2.6	21	1.6	6.0	430	190	192	7.6	51	15.7	15	---	232	0
	2/17/75	Ice	1.0	---	11.0	---	----	1.5	0	435	196	190	7.9	27	30.0	21	1.1	239	0

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
American Fork Creek	7/2/74	25	1.5	----	262	0.6	60	0.03	0.19	0.03	<.01	0.01	<.001	<.001
	8/8/74	28	0.3	0.25	395	0.6	0.29	0.03	0.15	<.01	<.01	<.01	<.001	<.001
	9/13/74	11.9	2.4	----	368	0.5	0.02	0.22	0.36	0.05	0.012	0.003	<.001	<.001
	10/11/74	27.0	2.0	----	384	0.7	0.09	----	0.32	0.02	<.01	<.01	<.001	<.001
	11/21/74	40.0	3.0	----	381	0.7	0.17	----	0.05	5.2	<.01	0.02	-----	<.001
	1/7/75	33	2.1	----	349.5	0.5	0.26	----	0.18	0.03	<.01	<.01	<.001	<.001
	2/17/75	31	3.7	0.21	353.3	0.7	0.66	<.03	0.02	<.01	<.01	0.02	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Table 10

Water Quality Data from Big Elk, Antelope, Fish, Mud, Big Coulee, Painted Robe, and Current Creeks.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Big Elk Creek	11/21/74	6.7	1.9	8.1	14.1	3.7	0	----	24	760	191	346	8.4	91	29	35	---	231	1
07N 13E 26CD	1/7/75	13	1.0	7.9	13.7	4.6	5	0.9	6.0	633	189	308	7.9	79	27	24	---	230	0
Antelope Creek 08N 15E 23AD	8/7/74	1	21	8.4	10.2	7.1	420	2	7	2170	197	800	8.4	164	95	235	5	235	2
Fish Creek 06N 20E 07DD	11/21/74	10.5	2.8	8.4	14.4	6.0	5	----	50	941	285	297	8.4	55	39	102	---	345	2
Mud Creek 06N 17E 15	10/16/74	----	----	7.8	----	---	----	----	506	5850	---	----	7.8	---	---	---	---	---	-
Big Coulee Creek	7/3/74	1.6	17.0	8.1	11.4	7.9	930	8.3	12	4135	297	1272	8.1	46	281	640	---	363	0
16N 22E 11BD	8/8/74	1.7	21.0	8.0	----	---	131	3.6	32	3658	288	866	8.1	164	181	525	8.7	351	0
Painted Robe Creek 06N 23E 15DB	11/21/74	0.01	4.0	8.1	14.5	7.3	----	----	10	5270	396	1668	8.4	212	277	815	---	470	6
Current Creek	9/11/74	7.5	28	8.4	----	---	TNTC	85	138	1192	224	422	8.3	83	52	112	4.5	268	2
07N 25E 07CC	2/12/75	Ice	1.0	---	10.0	2.5	---	64	2	8090	502	2628	7.7	534	315	1300	35	611	0

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Big Elk Creek	11/21/74	219	9.0	----	615	0.8	0.04	0.06	0.07	0.07	<.01	0.02	-----	<.001
07N 13E 26CD	1/7/75	164	1.4	----	525	0.6	0.18	----	0.10	0.01	<.01	<.01	<.001	<.001
Antelope Creek 08N 15E 23AD	8/7/74	1058	11.4	0.36	1806	3.6	0.25	0.03	0.20	0.02	<.01	<.01	0.001	<.001
Fish Creek 06N 20E 07DD	11/21/74	219	11.0	----	772.6	2.6	0.31	0.02	1.5	0.13	<.01	0.01	-----	<.001
Mud Creek 06N 17E 15	10/16/74	3200	166.4	----	------	---	----	----	0.60	0.08	0.03	0.12	0.004	-----
Big Coulee Creek	7/3/74	2244	42	----	3615	7.8	----	0.03	<.01	<.01	<.01	<.01	-----	-----
16N 22E 11BD	8/8/74	1974	2.0	0.26	3205	6.7	0.08	0.06	0.22	<.01	<.01	0.01	0.001	<.001
Painted Robe Creek 06N 23E 15DB	11/21/74	2800	92	----	4672.3	8.7	0.58	0.03	0.14	0.06	<.01	0.07	-----	<.001
Current Creek	9/11/74	430	2.5	0.29	954.9	2.4	0.15	0.03	2.6	0.69	0.01	0.04	<.001	-----
07N 25E 07CC	2/12/75	4100	475	3.0	7373.8	11.0	0.93	----	5.7	0.60	0.05	0.06	0.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Referen Montana Water Quality Bureau.

Table 11

Water Quality Data from the Musselshell River near Ryegate.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Ryegate	6/14/74	312	22	8.5	9.0	---	---	47	77	789	194	309	8.2	80	27	58	2.6	236	0
06N 20E 03CA	7/3/74	171	16	7.0	7.9	4.7	390	21	192	1086	218	369	8.5	80	41	100	3.3	254	6
	8/8/74	104	22	8.2	----	---	19	24	79	1161	211	496	8.4	62	83	100	4.2	251	3
	9/13/74	84	10	8.2	10.6	3.0	---	--	20	1241	284	456	8.1	133	30	150	---	346	0
	10/11/74	50	10	---	10.6	3.6	150	--	18	1364	248	515	8.0	101	64	125	---	303	0
	11/21/74	30	2.8	---	13.3	2.4	---	--	28	1402	276	536	8.7	107	65	125	---	315	11
	1/7/75	235(Ice)	1.0	---	12.2	2.7	---	4.5	6.0	1391	303	561	8.0	121	63	110	---	370	0
	2/17/75	Ice	1.0	---	8.9	---	---	7.8	6.0	1252	279	494	7.9	76	74	100	2.6	340	0

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Ryegate	6/14/74	235	4.8	0.29	644	1.4	0.40	0.18	2.2	0.12	<.01	<.01	<.001	<.001
06N 20E 03CA	7/3/74	341	8.5	----	835	2.3	1.4	----	0.95	0.07	<.01	0.02	<.001	<.001
	8/8/74	478	2.0	0.27	983	2.0	0.03	0.06	1.3	0.16	<.01	<.01	<.001	<.001
	9/13/74	442	20	----	1122	3.1	0.01	----	0.30	0.03	0.006	0.005	<.001	<.001
	10/11/74	494	8.0	----	1094	2.4	0.29	----	----	----	-----	-----	-----	-----
	11/21/74	507	12.1	----	1143	2.3	1.0	0.30	0.42	0.10	<.01	<.01	<.001	<.001
	1/7/75	475	9.5	----	1149	2.0	0.75	----	0.30	0.04	<.01	<.01	<.001	<.001
	2/17/75	415	8.1	0.32	1017.9	2.0	1.6	<.03	0.17	<.01	<.01	0.01	0.002	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

load is a result of the scouring that occurs during water releases. The natural alkali soils in this area contribute to the salt load carried by these waters. Periods of low flow reduce the silt load, but greatly increase the salt concentration thus making these waters undesirable for irrigation usage. In July, fecal coliforms were observed in excess of State standards (Table 12).

Little Careless Creek

This creek, north of Ryegate, emanates from the Big Snowy Mountains and except for excessive fecal coliforms is good quality, calcium-bicarbonate water (Table 12). Periphyton analysis indicates (Table 27) moderate enrichment exists.

Big Coulee Creek, Painted Robe Creek, Currant Creek

All of these streams are very hard to extremely hard waters of a sodium-sulfate type. Currant Creek has the best quality water. Fecal coliform concentrations were found in Currant Creek during the September sampling period (Table 10). A sediment load of 2.7 tons/day was also recorded.

Big Coulee and Painted Robe Creeks are very alkaline waters. These streams also were high in sulfates, sodium, and dissolved solids (Table 10); both streams would be considered marginal use waters. The alkalinity is a result of adjacent alkaline soils. Flora in Painted Robe Creek is typical (Table 27) of very saline conditions and approximates the flora of Arrow Creek near Stanford, Montana (Middle Missouri Basin Report, 1974).

The Lower Musselshell Basin

The Lower Musselshell basin is unlike the upper basin. The river is warmer, shallower, saltier, and carries excessive sediment. Changes in water quality are due to the surrounding geology, topography, and irrigation return flows.

Water sampling was conducted at Roundup, Musselshell, Melstone, and Mosby. Sampling was conducted upstream and downstream of Roundup. Examination of the data shows Roundup has no influence on the Musselshell River. The only parameter exceeding water quality standards was fecal coliforms (July, Table 13). Dissolved solids are high, and careful management practices should be utilized when using these waters for irrigation. The following illustrates the guidelines for salinity in irrigation water.

Classification	Dissolved Solids mg/l
No detrimental effects noticed	500
May have detrimental effects on sensitive crops	500 - 1,000
Adverse effects on many crops; requires careful management practices	1,000 - 2,000
Water that can be used on tolerant plants with permeable soils and careful management	2,000 - 5,000

(Reference: Water Quality Criteria, 1973)

Table 12

Water Quality Data from Careless Creek and Little Careless Creek.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Careless Creek	6/14/74	82	24.0	8.5	8.4	----	---	66	130	1186	265	401	8.3	76	51	120	3.7	314	4
06N 20E 02AB	7/3/74	79	17	7.9	----	----	370	63	150	1218	87	410	6.7	88	46	95	---	106	0
	8/8/74	77	20	8.4	----	----	100	83	182	1123	185	376	7.9	70	49	105	4.3	226	0
	9/13/74	48	11.0	8.4	11.0	2.8	---	--	48	1372	197	394	8.3	52	64	250	---	240	0
	10/11/74	16	11.0	8.2	----	----	0	--	12	3140	309	905	8.2	143	133	430	---	377	0
Little Careless Crk 10N 17E 09AA	11/8/74	4.6	3.9	8.5	----	---	TNTC	--	---	706	351	344	8.5	74	39	37	2.3	389	19

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Careless Creek	6/14/74	380	11.7	.34	961.5	2.6	0	0.03	3.1	0.11	0.01	0.16	<.001	<.001
06N 20E 02AB	7/3/74	377	7.6	---	898.9	2.0	177	2.2	4.8	0.15	<.01	0.09	<.001	<.001
	8/8/74	403	7.7	.26	865.3	2.4	0.18	0.15	3.2	0.05	<.01	0.03	<.001	<.001
	9/13/74	711	0.8	---	1318	5.5	0.02	0.12	0.38	0.03	0.008	<.01	0.006	<.001
	10/11/74	1456	13.0	---	2552	6.2	0.19	0.06	----	----	-----	----	-----	-----
Little Careless Crk 10N 17E 09AA	11/8/74	64	4.0	---	628.2	0.9	0.09	0.03	0.27	0.05	<.01	<.01	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Concentrations of dissolved solids increase downstream of Roundup as does the sodium adsorption ratio (SAR)(Figure 7 and Table 12). These parameters continue to increase downstream to Mosby. Nitrate concentrations attain their highest concentrations at Mosby. A comparison of 1966 data (Table 14) and 1974 data (Table 15) indicate increasing concentrations of nitrates. Figures 3, 4, 5, 6 and 7 point out the downstream changes that occur in the Musselshell Basin. The nitrate and dissolved solids concentrations do not constitute a violation of Montana Water Quality Standards but their continued downstream accrual significantly inhibits usage of these waters.

A water quality control study (1966) concluded that a lower Musselshell dam would be feasible. However, the hazard of salt accumulation was termed a problem. This study pointed out the project feasibility would then depend on reducing irrigated acreage or maintaining high flows. The latter solution does not remove the salt problem.

Changes in water quality for the past eight years can be noted in Tables 14 and 15 and Figure 6. Figure 6 shows that the SAR and dissolved solids concentration have increased. To determine the validity of this trend, several more years of data collection are needed.

Fecal coliforms in excess of State standards were observed at Musselshell and Mosby. Parameters at Mosby considered excessive are nitrate, suspended sediment, and salts. Suspended sediment and salts are the greatest water quality problem in the lower Musselshell Basin.

Figures compiled by Montana Department of Natural Resources and Conservation (DNR&C) show that consumptive use of irrigation water in this irrigation basin is 76, 298 af, diversion requirements are 311,418 af with a return flow of 164,584 af. Records by the USGS show that the 41-year average discharge for the Musselshell at Mosby is 180,400 af.

Tables 20 and 21 show water quality at Musselshell and Melstone. These data show the Musselshell changes water quality between these two sites, particularly SAR, specific conductance, sulfates, dissolved solids, and sodium. These changes are due to drainage of saline soils and irrigation return flows. Excessive coliform concentrations were found at both sites (Tables 20 and 21).

Flatwillow Creek

Flatwillow Creek drains most of Petroleum County and part of Fergus County. This drainage of 1,855 mi^2 contains Box Elder, McDonald and Flatwillow Creeks as major streams. Water quality was determined at five sites: Flatwillow, North Willow, Box Elder, McDonald, and Yellow Water Creeks.

During this survey, two sampling stations were utilized: one station south of Winnett (Highway 244); the other at the mouth of Flatwillow Creek, south

Table 13

Water Quality Data from the Musselshell River at USGS Gaging Station at Musselshell, Two Dot, and South of Shawmut.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Two Dot	1/7/75	Ice	-1.0	---	11.6	7.5	45	1.7	8.0	795	231	360	7.8	8.6	3.5	38	---	281	0
08N 13E 27AA	2/17/75	Ice	1.0	---	10.1	---	--	2.3	2.0	756	217	336	7.8	50	51	39	2.1	265	0
South of Shawmut	2/17/75		1.0	---	----	---	--	2.8	4.0	1012	249	410	7.9	49	70	71	2.3	303	0
07N 18E 30																			
USGS Gaging Station	6/14/74	310	21.0	8.6	8.4	---	--	81	140	1092	237	418	8.3	78	54	120	3.8	284	3
09N 29E 20BB	7/1/74	124	24.5	8.2	8.4	5.2	10	13	37	1185	201	443	8.2	73	64	170	3.9	245	0
	8/7/74	222	26.0	8.5	9.6	7.0	0	--	51	1370	207	444	8.1	79	60	130	5.2	252	0
	1/6/75	69.2	2.5	---	12.1	2.3	0	2.9	6.0	2187	372	788	7.8	148	102	250	---	454	0
	2/12/75	60	1.0	---	10.7	2.4	--	1.5	2.0	1847	290	690	8.0	65	128	203	3.6	354	0

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Two Dot	1/7/75	194	4.5	----	640	0.9	0.84	----	0.14	0.02	<.01	<.01	<.001	<.001
08N 13E 27AA	2/17/75	199	4.3	0.30	612.1	0.9	1.2	0.06	0.02	0.01	<.01	0.02	<.001	<.001
South of Shawmut	2/17/74	302	6.0	0.30	813.0	1.5	9.4	0.03	0.10	<.01	<.01	<.01	0.001	<.001
07N 18E 30														
USGS Gaging Station	6/14/74	414	12.5	0.33	969	2.6	0.16	0.05	3.8	0.19	<.01	0.06	<.001	<.001
09N 29E 20BB	7/1/74	561	11.5	----	1191	3.5	63.0	0.03	0.77	0.06	<.01	<.01	<.001	0.001
	8/7/74	490	2.5	0.30	1019	2.7	0.21	0.03	0.95	0.04	<.01	<.01	0.002	<.001
	1/6/75	893	23	----	1869	3.9	0.49	----	0.30	0.03	<.01	<.01	<.001	<.001
	2/12/75	785	19.0	0.32	1558.9	3.4	0.89	0.06	0.09	<.01	0.02	<.01	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Table 14

Water Quality Data from the Musselshell River at Melstone.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Melstone	6/14/74	----	21	8.5	8.8	---	----	120	200	1177	233	410	8.3	89	45	126	2.8	279	2
10N 31E 21AD	8/7/74	38	27	8.4	9.4	8.5	TNTC	44	89	2760	247	760	8.2	111	116	355	7.5	301	0
	9/9/74	145	21.5	8.1	----	---	----	---	52	1536	215	480	8.3	84	66	170	---	262	0
	11/20/74	74	3.8	8.3	15.2	4.5	47	---	26	2158	282	678	8.2	112	97	275	---	344	0
	1/6/75	70 E	1.5	8.2	12.1	3.2	6	6.1	10	1299	365	856	7.9	144	121	315	---	445	0
	2/12/75	Ice	1.0	---	10.2	2.2	----	5.4	6	2124	326	769	5.4	152	94	265	4.4	398	0

E - Estimate

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Melstone	6/14/74	430	10.3	0.30	986	2.7	0.48	0.06	5.2	0.24	0.01	0.09	<.001	<.001
10N 31E 21AD	8/7/74	1247	1.0	0.30	2140	5.6	0.52	0.03	1.2	0.06	<.01	0.02	<.001	<.001
	9/9/74	607	12.0	----	1201	3.4	0.06	0.09	1.0	0.08	<.01	0.02	0.007	<.001
	11/20/74	905	24	----	1758	4.6	1.5	0.03	0.21	0.09	<.01	<.01	-----	<.001
	1/6/75	1092	27	----	2145	4.7	2.1	0.06	0.96	0.06	<.01	<.01	<.001	<.001
	2/12/75	959	23	0.34	1898.6	4.2	2.5	<.03	0.42	0.01	<.01	0.04	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Table 15

Water Quality Data from the Musselshell River Upstream and Downstream of Roundup.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
USGS Gaging Station	6/14/74	277	23	8.5	8.6	---	----	55	161	1212	241	437	8.3	82	57	120	3.8	285	4
08N 23E 22D	7/1/74	106	23.8	8.2	9.2	7.0	1790	15	32	1203	253	425	8.3	85	55	132	3.0	296	0
	8/6/74	277	24	8.4	9.6	6.7	20	--	51	1700	212	426	8.0	84	70	145	4.0	259	0
	9/9/74	144	18	8.2	---	---	----	9	38	1460	215	452	8.1	85	64	146	---	262	0
	1/6/75	75	1.8	---	8.9	---	0	2.6	8.0	1988	559	714	7.7	145	85	215	---	437	0
	2/12/75	136	1.0	---	11.5	2.7	----	3.0	2.0	1818	318	640	8.0	131	76	196	3.9	387	0
Downstream of Roundup	8/6/74	277	24.5	8.3	9.2	5.6	10	--	36	1750	204	475	8.3	70	68	125	4.2	236	0
08N 26E 18DB	9/9/74	144	18.0	8.1	---	---	----	12	36	1460	245	444	---	---	--	---	---	---	-
	10/10/74	68	13.0	8.2	9.3	3.8	17	--	8	1660	240	553	8.2	96	76	168	---	293	0
	11/20/74	61	2.0	8.4	15.2	6.6	14	--	14	1970	264	622	8.4	108	85	215	---	322	0
	1/6/75	76	2.0	7.7	14.0	4.8	5	4.2	<.9	1899	350	815	7.7	150	107	190	---	427	0

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
USGS Gaging Station	6/14/74	427	12.1	0.34	991.5	2.5	0.20	0.05	2.9	0.15	<.01	0.13	<.001	<.001
08N 23E 22D	7/1/74	416	11.0	----	997.7	2.7	----	----	1.0	0.04	0.03	0.10	<.001	<.001
	8/6/74	575	14.0	0.32	1151.7	2.8	0.13	----	0.83	0.09	<.01	0.06	<.001	<.001
	9/9/74	527	12.0	----	1096.7	2.9	0.16	0.12	0.58	0.05	<.01	0.04	0.007	<.001
	1/6/75	786	18.6	----	1687.6	3.5	0.40	----	0.50	0.03	<.01	<.01	<.001	<.001
	2/12/75	704	14.8	0.25	1514.7	3.4	0.93	0.09	0.11	<.01	0.03	0.02	0.00.	<.001
Downstream of Roundup	8/6/74	572	4.0	0.30	1079	2.5	0.13	-----	1.2	0.02	<.01	0.02	<.001	<.001
08N 26E 18DB	9/9/74	---	----	----	------	---	----	-----	----	----	----	----	-----	-----
	10/10/74	634	15.0	----	1283	3.1	1.3	0.24	----	----	----	----	-----	-----
	11/20/74	775	20.0	----	1526	3.8	0.27	0.03	0.12	0.05	<.01	<.01	-----	<.001
	1/6/75	819	18.0	----	1711.4	2.9	0.35	----	0.34	0.02	<.01	<.01	<.001	-----

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

of Mosby. The data shows concentrations of all major chemical constituents increased downstream of Winnett (Tables 26 and 27). The increases of sodium, sulfate, and dissolved solids tend to make the downstream portions of Flatwillow Creek a saline type stream. A comparison of upstream and downstream sodium adsorption ratios (SAR) shows that during August waters from lower Flatwillow Creek are unfit for irrigation purposes. The preceding is based on guidelines for salinity in irrigation water which states that water containing 2,000-5,000 mg/l total dissolved solids should be used only on tolerant plants with permeable soils and careful management practices (Water Quality Criteria 1972). Dissolved solids values for lower Flatwillow Creek are found in Table 27.

Thus, Flatwillow Creek begins as a calcium bicarbonate water and terminates as a sodium-sulfate water. Change in water type is partially due to the area geology and irrigation returns, or salt accrual in Petrolia Reservoir. Periphyton analysis of samples from Flatwillow Creek (Table 28) indicates a water that is well oxygenated,with a low organic load, and a flora typical of a saline reservoir discharge.

Examination of past water quality data (USGS 1965, 1966) and present data (1974-75, Montana Department of Health and Environmental Sciences) (Tables 22 and 26) indicates that the quality of water in this sub-basin has not significantly changed in the last ten years. This sub-basin's major pollutant is suspended sediment. The bulk of this sediment load is carried during the spring months (Tables 23, 24 and 25). Petroleum County has a higher sediment yield per square mile than any other basin county. A Bureau of Reclamation report (1972) lists this sediment yield at 500 tons per square mile per year. This county is 44 percent publicly owned, which is the largest public domain in the Musselshell basin. Other sub-basin streams of importance are: Box Elder, McDonald and Yellow Water Creeks.

Box Elder Creek

This stream drains 16.2 mi^2 and is a hard sodium-sulfate water. Partial flow records are available from 1955 to 1973. Water quality data (Table 26) show this stream to be alkaline with high dissolved solids. This together with a high sodium adsorption ratio (SAR) renders this stream undesirable for irrigation. The salinity of this stream is attributed to the area's natural geology, possibly aggravated by dryland farming practices.

McDonald Creek

McDonald Creek south of Winnett flows eastward until its confluence with Flatwillow Creek. This stream is a calcium-magnesium-sulfate water of extreme hardness (Table 26). No other unusual water quality parameters were observed with the exception of a high nitrate and SO_4 value.

Table 16
Water Quality Data from near Mosby, MT.

Date	Discharge cfs	Silica	Temperature °C	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Fluoride	Nitrate	Boron	Dissolved Solids ppm	Tons/day	Total Hardness	Conductivity umhos/cm @ 25°C	pH	Color
10/1-12/65	303	7.7	9.0	83	55	138	3.0	262	0	482	12	0.3	0.1	0.14	971	794	432	1320	8.0	2
10/13-22/65	196	7.4	7.8	85	61	156	3.3	269	0	544	12	0.3	0.1	0.16	1000	529	463	1450	8.1	2
10/23-31/65	182	6.8	7.2	88	63	162	3.2	268	0	570	12	0.3	0.1	0.15	1040	511	480	1480	8.0	2
11/1-10/65	138	5.9	6.2	89	70	196	3.6	288	0	678	19	0.3	0.0	0.17	1200	447	510	1710	8.0	5
11/11-20/65	130	6.8	1.0	89	80	206	3.6	292	0	702	19	0.3	0.0	0.18	1250	439	552	1770	7.8	3
11/21-30/65	109	8.3	0.0	98	97	228	3.6	311	0	795	21	0.3	0.0	0.18	1400	412	618	1930	7.8	1
12/1-17/65	118	9.8	0.0	97	79	191	3.5	308	0	680	18	0.5	0.4	0.21	1230	392	567	1680	8.2	3
12/18-31/65	104	9.4	0.0	102	93	212	3.9	351	0	752	19	0.5	0.6	0.20	1370	385	636	1870	8.1	4
1/1-14/66	122	10.0	0.0	99	89	186	3.5	352	0	682	18	0.5	0.9	0.18	1260	415	613	1730	8.2	3
1/15-31/66	89.4	9.8	0.0	110	74	173	3.3	339	4	628	15	0.4	0.9	0.12	1190	287	578	1650	8.3	2
2/1-8/66	87.5	9.1	0.0	123	77	205	4.0	366	0	706	20	0.7	0.7	0.16	1330	314	623	1780	7.8	-
2/9-20/66	72.1	8.7	1.0	121	73	185	4.0	366	0	643	18	0.7	0.9	0.18	1230	239	602	1680	7.8	-
2/21-28/66	101	8.3	0.5	121	70	182	4.0	366	0	626	20	0.6	0.9	0.14	1210	330	592	1660	7.9	-
3/1-9/66	117	8	0.0	85	76	150	8.0	320	0	545	17	0.5	0.8	0.11	1050	332	526	1490	8.0	-
3/10-14/66	800	5.7	0.5	55	33	124	13.0	131	0	409	11	0.4	1.6	0.19	786	1700	273	1070	7.1	-
3/13-31/66	452	7.6	1.6	74	49	127	13.0	247	0	412	19	0.4	1.2	0.10	884	1080	385	1220	8.0	-
4/1-10/66	346	8.0	7.0	83	54	118	4.6	264	0	447	18	0.6	0.6	0.16	922	861	426	1230	8.0	-
4/11-20/66	241	4.7	11.0	88	66	152	4.6	272	0	581	20	0.7	0.0	0.17	1050	683	489	1490	8.0	-
4/21-30/66	212	5.0	4.5	87	70	159	4.2	275	0	602	21	0.7	0.2	0.19	1080	618	506	1520	8.1	-
5/1-12/66	241	5.3	9.5	88	59	154	3.4	262	0	538	16	0.5	0.0	0.13	993	646	463	1420	8.1	1
5/13-18/66	505	12.0	3.0	65	31	78	3.0	210	0	262	6.2	0.4	0.2	0.18	590	804	289	859	8.0	5
5/19-23/66	192	8.5	18.0	90	54	150	3.4	265	3	508	14	0.4	0.2	0.12	962	499	448	1360	8.3	1
5/24-31/66	87.9	5.0	10.0	100	75	222	4.4	288	0	742	24	0.4	0.0	0.15	1310	311	558	1840	8.2	5
6/1-15/66	126	8.8	16.0	80	72	182	4.4	270	0	612	17	0.5	0.0	0.20	1110	378	496	1580	7.9	2
6/16-30/66	48.1	2.5	21.0	82	108	288	5.0	284	0	955	26	0.4	0.1	0.19	1610	209	649	2260	8.1	2
7/1-6/66	189	8.7	22.0	53	138	290	7.6	244	4	1060	15	0.5	0.2	0.30	1700	868	700	2280	8.3	-
7/7-16/66	214	9.1	21.0	84	46	137	5.2	235	0	468	10	0.5	1.9	0.15	911	526	399	1250	7.8	5
7/17-31/66	43.8	6.4	24.0	114	73	278	7.6	239	0	960	18	0.6	0.8	0.24	1580	187	586	2190	7.7	10
8/1-6/66	56.8	4.1	21.0	78	92	267	5.7	263	0	870	20	0.4	0.1	0.19	1470	225	574	2010	8.2	2
8/7-30/66	72.6	4.7	21.0	88	70	203	4.7	250	0	710	17	0.3	0.1	0.16	1220	239	507	1670	7.9	2
8/31-9/16/66	65.8	2.8	24.0	83	78	221	4.4	248	0	735	18	0.4	0.3	0.20	1260	224	528	1780	8.0	5
9/17-30/66	79.2	2.7	18.1	84	73	197	4.0	248	0	700	16	0.4	0.3	0.18	1200	257	510	1670	8.0	1
Weighted Average	-----	7.4		84	63	162	5.9	264	-	563	16	0.5	0.6	0.16	1060	462	470	1470	7.8	-
Time Weighted Average	162	7.0		91	73	188	4.9	282	-	655	17	0.5	0.4	0.17	1180	---	525	1650	7.9	-
Tons/day		3.2		37	28	71	2.6	116	-	247	7.1	0.2	0.2	0.07	----	---	---	----	---	-

Location: Five miles South of Mosby.

Reference: Water Resources Data for Montana, Part 2. U.S.G.S. 1966.

Chemical analysis in parts per million.

Table 17

Water Quality Data from the Musselshell River at Mosby.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Mosby	7/1/74	156 E	26.5	8.2	7.1	3.8	50	96	211	1488	209	535	8.2	89	76	160	5.0	255	0
14N 30E 02BC	8/7/74	2.3	24.0	8.2	8.5	4.8	10	35	37	3884	267	1275	8.2	222	175	530	8.0	326	0
	9/9/74	138	21.6	7.9	----	---	----	35	87	1588	199	385	8.1	80	45	240	---	243	0
	10/10/74	74	14.0	---	10.6	3.8	TNTC	--	40	2052	243	642	8.2	101	95	260	---	296	0
	11/20/74	78	2.6	---	14.8	5.8	3	--	50	2430	275	772	8.4	135	105	280	---	321	7
	1/6/75	58	1.0	---	14.8	6.1	1	9.0	32	2269	358	947	7.6	183	119	340	---	437	0
	2/12/75	Ice	0	---	9.9	3.1	----	5.2	2	2507	375	959	7.8	193	116	270	10.0	457	0

E - Estimate

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Mosby	7/1/74	756	53	---	1398	3.0	4.4	0.03	3.6	0.08	<.01	<.01	-----	<.001
14N 30E 02BC	8/7/74	2078	1.3	---	3340	6.5	---	0.03	0.73	0.09	0.01	0.02	<.001	<.001
	9/9/74	658	12.0	---	1278	5.3	0.15	0.09	1.9	0.07	0.01	0.03	0.003	<.001
	10/10/74	900	18.4	---	1670	4.5	0.35	0.06	0.11	0.05	<.01	0.03	<.001	<.001
	11/20/74	1029	24.0	---	1904	4.4	1.4	0.27	0.60	0.10	<.01	0.03	-----	<.001
	1/6/75	1254	26	---	2360	4.8	1.5	0.03	1.0	0.04	<.01	<.01	<.001	<.001
	2/12/75	1125	24	0.44	2197.5	3.8	1.7	<.03	0.11	<.01	<.01	0.02	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Table 18
Suspended Sediment Data from Musselshell River near Mosby, MT.
November 1962 to September 1963.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/month
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	--	-----	------	--	---	---	------	---	-------
November	24	90	120	30	40	22	30	2	307
December	16	114	300	1	64	12	92	2	1,063
January	4	48	260	25	8	18	34	T	169
February	5	200	2,100	2	10	17	1,100	T	7,555
March	1	160	720	21	60	12	310	2	1,303
April	19	70	310	2	56	44	59	7	484
May	15	232	1,200	28	36	110	860	11	2,670
June	21	900	12,000	3	150	340	29,000	140	82,060
July	24	1,400	490	23	45	110	490	13	2,604
August	21	118	190	13	31	120	61	10	1,091
September	3	240	7,000	29	22	60	4,500	4	9,005

Total Discharge for year cfs days 39,915
Total Load for year (tons) 108,311

Ref: Water Resources Data for Montana
Water Quality Records U.S.G.S. 1963

Table 19
Suspended Sediment Date from Musselshell River near Mosby, MT.
Water Year October 1963 to September 1964.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/month
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	17	46	140	13	15	70	17	3	204
November	27	62	72	14	41	7	12	1	143
December	17	18	190	27	22	9	9	1	200
January	4	25	160	17	24	9	11	1	133
February	15	32	20	11	32	6	2	1	41
March	31	46	170	27	40	8	21	1	131
April	26	106	8,000	13	42	18	1,800	2	3,679
May	4	90	8,300	31	42	65	2,000	7	6,513
June	21	2,470	3,200	1	33	70	23,000	6	154,664
July	1	828	560	21	48	160	1,300	21	8,157
August	20	808	8,100	15	98	100	20,000	26	3,725
September	1	223	250	30	54	85	150	12	1,235

Total Discharge for Year cfs days 59,033
Total Load for Year (tons) 206,016

Ref: Water Resources Data for Montana
Water Quality Records U.S.G.S. 1964

Table 20
Suspended Sediment Data from Musselshell River near Mosby, MT.
Water Year October 1964 to September 1965.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/month
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	10	56	12	18	32	1	2	T	21
November	24	59	62	1	54	3	10	T	61
December	5	37	10	21	22	39	2	1	53
January	20	400	38	3	30	6	41	T	358
February	19	1,500	950	5	200	25	3,800	14	9,608
March	9	466	500	3	390	40	630	42	3,878
April	2	480	6,500	30	288	210	8,400	160	60,690
May	7	1,760	9,600	3	214	150	54,000	87	88,547
June	16	2,170	13,000	12	184	120	100,000	60	171,383
July	1	872	960	26	38	120	2,300	12	15,395
August	29	278	310	21	53	80	230	11	2,147
September	14	522	560	7	206	130	790	72	5,909

Total Discharge for year cfs days 96,694
Total Load for year (tons) 358,050

Ref: Water Resources Data for Montana
Water Quality Records U.S.G.S. 1965

Table 21
Suspended Sediment Data from Musselshell River near Mosby, MT.
Water Year October 1965 to September 1966.

Month	Suspended Sediment ppm					tons/day			Monthly Totals tons/month
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	3	400	140	30	151	8	150	3	1,309
November	26	80	70	7	114	3	70	1	196
December	5	145	150	28	80	16	59	3	565
January	8	170	110	28	55	60	50	9	800
February	28	90	100	20	70	60	24	11	481
March	18	854	2,500	4	60	58	5,800	9	36,501
April	2	407	560	29	197	70	620	37	5,018
May	15	694	1,500	31	44	89	2,800	11	11,775
June	5	282	550	20	31	100	420	8	1,912
July	2	220	27,000	26	26	110	17,000	8	43,409
August	4	74	280	20	47	70	56	9	846
September	20	90	130	30	84	50	32	11	551

Total Discharge cfs days 59,230
Total Load for year (tons) 103,363

Ref: Water Resources Data for Montana, Part 2.
Water Quality Records U.S.G.S. 1966.

Table 22
Water Quality Data from Flatwillow Creek near Mosby, MT.

Date	Discharge cfs	Silica	Temperature °C	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Fluoride	Nitrate	Boron	Dissolved Solids ppm	Tons/day	Total Hardness	Conductivity umhos/cm @ 25°C	pH	Color
10/1-15/65	7.6	2.3	15.7	242	160	430	7.3	288	0	1890	16	0.6	0.1	0.47	2890	59.2	1260	3480	7.9	3
10/16-31/65	9.9	2.8	12.9	260	175	450	7.3	311	0	2010	20	0.6	0.1	0.52	3080	82.2	1370	3700	8.0	3
11/1-15/65	12.1	3.8	6.6	238	172	440	7.2	288	0	1850	22	0.7	0.0	0.44	2880	94.0	1300	3530	7.6	8
11/16-26/65	15.3	4.8	1.0	233	160	475	6.8	332	0	1880	19	0.7	0.0	0.47	2940	121	1240	3590	7.7	6
11/27-12/4/65	14.1	5.0	2.1	82	279	456	7.4	352	0	1940	23	0.8	0.1	0.48	2970	113	1350	3640	8.2	4
12/5-13/65	12.8	4.7	0.8	77	262	424	7.2	328	0	1830	22	0.7	0.2	0.47	2790	96.3	1270	3480	8.1	3
12/14-31/65	10.2	4.9	1.8	282	184	494	7.8	375	0	2150	24	0.9	0.1	0.48	3330	91.6	1460	3940	8.2	4
1/1-17/66	10.2	6.0	0.5	307	193	525	7.8	445	0	2240	26	0.8	0.4	0.54	3530	97.1	1560	4090	7.8	4
1/18-31/66	4.8	6.0	0	315	188	542	7.4	468	0	2260	26	0.8	0.7	0.55	3580	46.3	1560	4160	7.8	3
2/1-6/66	6.4	8.8	0.5	307	189	490	7.8	439	0	2220	32	1.2	0.4	0.50	3470	60.0	1540	4610	7.6	-
2/7-17/66	4.9	9.6	0	290	171	480	7.5	418	0	2070	30	1.2	1.0	0.46	3270	43.2	1430	3970	7.6	-
2/18-28-66	6.5	8.6	0	279	159	445	7.0	406	0	1920	28	1.1	2.0	0.46	3050	53.5	1350	3680	7.6	-
3/1-9/66	10.2	6.9	0.5	250	163	400	10.0	398	0	1770	26	1.0	1.3	0.34	2820	77.6	1290	3460	8.1	-
3/10-22/66	527	4.8	3.6	78	48	104	8.0	152	0	487	8.9	0.6	1.3	0.15	898	1280	394	1200	7.8	-
3/23-31/66	121	6.7	7.4	123	64	132	17.0	220	0	653	11	0.7	1.5	0.12	1120	366	568	1540	7.8	-
4/1-8/66	132	7.4	7.2	120	70	120	2.0	234	0	643	8.9	0.8	1.1	0.60	1090	388	588	1490	7.7	-
4/9-18/66	77	5.6	10.0	154	102	205	3.0	276	0	975	12.0	0.9	0.5	0.54	1590	331	802	2120	7.6	-
4/19-30/66	36.4	4.4	7.2	171	122	263	4.0	287	0	1240	16.0	1.0	0.6	0.42	1960	193	928	2520	8.1	-
5/1-6/66	15.3	4.5	8.0	189	138	380	6.9	277	0	1540	17	0.6	0.1	0.45	2410	99.5	1040	3080	7.9	2
5/7-19/66	25.9	3.6	4.5	206	142	460	7.9	267	0	1780	22	0.7	0.3	0.52	2750	192	1100	3480	8.1	2
5/20-31/66	24.7	3.0	8.3	219	149	460	8.1	294	0	1770	21	0.8	0.2	0.46	2780	185	1160	3480	8.0	2
6/1-16/66	6.7	2.6	15.7	248	161	526	8.8	320	0	2020	29	1.0	0.0	0.70	3150	57.0	1280	3780	7.9	3
6/17-26/66	2.1	3.3	5.0	266	174	595	9.3	319	0	2250	34	0.9	0.0	0.52	3490	19.7	1380	4220	7.9	2
7/28-8/2/66	18.6	6.9	27.1	224	101	322	14.0	154	0	1460	17	0.8	1.3	0.39	2220	111	976	2890	7.4	10
Weighted Average	34.8	5.2	----	123	81	189	7.8	211	-	847	12	0.7	1.0	0.28	1420	176	641	1830	7.7	-
Tons/day	-----	0.6	----	15	10	24	1.0	26	-	106	1.5	0.1	0.1	0.03	----	------	----	----	---	-

Location: County highway bridge five miles South of Mosby.

Reference: Water Resources Data for Montana, Part 2. U.S.G.S. 1966.

Chemical analysis in parts per million.

Table 23
Suspended Sediment Data from Flatwillow Creek near Mosby, MT.
March 1964 to September 1964.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/day
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
March		1.5	33		1.5	33	T	T	5
April	10	54	280	1	6.0	67	41	1	192
May	4	1,660	7,000	1	7.2	180	31,000	3	101,850
June	20	3,130	4,500	7	125	160	38,000	54	172,179
July	10	312	2,600	28	48	140	2,400	18	12,740
August	21	288	4,900	19	18	160	4,400	8	9,368
September	7	29	250	26	28	110	20	8	372

Total Discharge for Year cfs days 51,321.7
Total Load for Period March 1 to September 30 (tons) 296,706

Ref: Water Resources Data for Montana
Water Quality Records U.S.G.S. 1964

Table 24
Suspended Sediment Date from Flatwillow Creek near Mosby, MT.
Water Year October 1964 to September 1965.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/day
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	3	26	160	28	26	10	11	1	85
November	15	30	70	9	29	10	6	1	58
December	18	17	90	28	19	20	4	1	64
January	21	48	140	1	19	10	18	1	173
February	20	1,000	2,400	1	42	32	6,480	4	10,905
March	7	395	420	23	62	100	450	17	3,846
April	6	622	2,100	30	272	480	4,000	350	47,180
May	7	1,140	7,800	31	202	120	49,000	65	103,495
June	16	538	1,200	27	82	110	1,180	24	4,743
July	10	112	3,100	31	8.7	120	1,500	3	5,053
August	5	18	170	29	4.2	72	15	1	102
September	14	8.7	160	3	3.4	92	4	1	70

Total Discharge for year cfs days 50,361.4
Total Load for Year (tons) 175,774

Ref: Water Resources Data for Montana
Water Quality Records U.S.G.S. 1965

Table 25
Suspended Sediment Data from Flatwillow Creek near Mosby, MT.
Water Year October 1965 to September 1966.

Month	Suspended Sediment ppm						tons/day		Monthly Totals tons/day
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	1	10	120	31	11	12	3.2	0.4	26.4
November	22	21	100	1	10	16	5.7	0.4	61.6
December	26	8.5	170	31	9.5	15	4.0	0.4	51.6
January	8	16	100	27	3	83	4.3	0.7	64.5
February	25	8.5	110	10	5	62	2.5	0.8	41.5
March	14	910	3,700	5	3	120	9,100	1.0	36,740.7
April	1	163	620	30	17	120	270	5.5	1,676.3
May	18	33	290	1	15	110	26	4.5	401.9
June	1	13	200	29	0.4	190	7.0	0.2	58.7
July	28	98	21,000	31	1.7	88	16,000	0.4	16,005.6
August	1	1.0	0.2	3	0	0	0.2	0	0.2
September	---	-----	--------	---	----	---	--------	---	--------

Total Discharge for year cfs days 12,705.9
Total Load for year (tons) 55,129

Ref: Water Resources Data for Montana, Part 2
Water Quality Records U.S.G.S. 1966

Table 26

Water Quality Data from Box Elder Creek, McDonald Creek, Yellow Water Creek, and Flat Willow Creek.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
Box Elder Creek	7/1/74	0.2	26.3	8.4	8.1	4.1	130	8	7.0	3061	191	541	8.5	91	76	523	9.0	234	4
28E 15N 34C	8/8/74	0	18.0	9.0	----	---	4	36	32	3682	313	276	8.7	32	48	770	10	350	16
McDonald Creek	7/1/74	11.3	24.5	8.0	8.4	4.5	130	31	33	2203	181	1004	7.4	199	123	156	6.0	221	0
14N 26E 12AD	8/8/74	8.2	19.0	8.2	8.5	4.7	3	37	57	2327	197	1040	8.2	222	118	110	6.0	240	0
Yellow Water Creek	7/1/74	0.3	25.8	8.4	12.8	8.4	1800	36	63	7850	294	2890	7.8	200	580	1297	9.0	358	0
13N 26E 06CB	8/8/74	0	18.0	8.2	4.5	4.5	TNTC	32	22	8820	464	3405	8.1	283	656	2700	14.0	566	0
Flat Willow Creek	7/1/74	64	20.5	7.3	8.8	3.6	50	20	23	768	210	367	7.9	70	47	15	2.9	255	0
12N 25E 24B	8/8/74	3.4	17.4	8.0	7.5	3.9	33	14	6	1118	223	375	8.2	114	70	29	2.0	272	0
	2/12/75	20 E	1.0	---	11.6	2.8	----	51	--	1437	293	784	7.7	191	75	35	2.8	357	0

E - Estimate.

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
Box Elder Creek	7/1/74	1370	18.5	----	2372.7	9.8	46	1.2	0.32	0.02	<.01	0.05	<.001	<.001
28E 15N 34C	8/8/74	1617	1.1	0.81	2844.2	20.2	0.18	0.09	0.33	0.02	0.01	0.03	<.001	<.001
McDonald Creek	7/1/74	1070	6.5	----	1838	2.1	56	0.60	1.1	0.36	<.01	0.02	<.001	<.001
14N 26E 12AD	8/8/74	1224	1.1	0.60	1922	1.5	-----	0.03	0.78	0.18	0.01	0.03	<.001	<.001
Yellow Water Creek	7/1/74	5147	47	----	7640.9	10.5	1.3	0.19	1.5	0.58	0.01	0.05	0.002	<.001
13N 26E 06CB	8/8/74	8200	0.3	1.5	12421	20.1	0.25	1.1	0.8	0.71	<.01	0.03	<.001	<.001
Flat Willow Creek	7/1/74	331	7.5	----	729.7	0.3	1.2	0.04	0.97	0.06	<.01	<.01	<.001	<.001
12N 25E 24B	8/8/74	390	0.2	0.47	881.9	0.5	3.5	0.03	0.29	0.14	<.01	<.01	0.002	<.001
	2/12/75	595	2.8	0.56	1259.1	0.5	0.49	0.12	----	----	0.02	0.03	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Yellow Water Creek

This small stream south of Winnett is a sodium sulfate water of extreme hardness and high dissolved solids making this water undesirable for livestock or irrigation (Table 26). Fecal coliform concentrations exceed state water quality standards. The salinity of this stream is attributed to the area's natural geology and possible influence of irrigation or dryland farming practices.

North Willow Creek

North Willow Creek is a sodium sulfate water (Table 27). Recorded SAR values were among the highest in the basin. The natural geology influences the stream's water type. Further investigation should be conducted to determine if area groundwater supplies have the same sodium sulfate problems.

Chemical analyses of this sub-basin show that the waters are basically good but have a salt and sediment problem. Area residents indicated that trout are no longer found in their past abundance. This change to a sucker-type fishery is one effect of long-term water quality changes that are only reflected in the aquatic biota.

The decline of a viable trout fishery has many causes. The most noticeable cause may be heavy silt loads caused by removal of streamside vegetation.

Fecal coliforms were listed as excessive in the following streams: Yellow Water, Little Careless, Currant, Careless, Antelope, and American Fork Creeks. Segments of the Musselshell with high coliforms were at Harlowton and Roundup. Probable sources are livestock and unauthorized septic tank discharges.

Table 27

Water Quality Data from North Willow Creek and Flatwillow Creek at FAS 500.

Sampling Site	Date	Flow (cfs)	Temp (°C)	Field pH	DO	BOD	F.C.	Turb JTU	TSS	SC	TA	TH	Lab pH	Ca	Mg	Na	K	HCO_3	CO_3
North Willow @ FAS	7/1/74	0.5	27.0	6.2	10.3	8.1	10	2	28	6334	34	1226	6.2	251	146	1700	11.5	41	0
500	8/7/74	0	25.0	8.0	9.3	6.5	170	75	127	8940	130	1655	7.9	311	214	2000	17	159	0
13N 30E 34BD	January--------Ice Cover																		
Flatwillow @ FAS 500	7/1/74	47.6	26	8.1	7.3	5.1	0	50	78	1899	207	795	8.1	123	119	210	6.0	252	0
14N 30E 33CB	8/7/74	4.4	25	8.2	----	---	0	32	33	3640	210	1255	8.2	218	172	780	8.0	256	0
	9/9/74	3.0	24	8.0	----	---	---	--	1.0	3006	205	1035	8.0	193	134	400	----	250	0
	1/6/75	10 E	1.0	---	14.1	4.6	5	6	22	3854	361	1611	7.8	321	197	410	----	440	0

E = Estimate

Sampling Site	Date	SO_4	Cl	F	CDS	SAR	NO_3	PO_4	Fe	Mn	Cu	Zn	As	Cd
North Willow @ FAS	7/1/74	4560	307	----	7293.5	21.1	277	0.03	0.32	0.04	0.02	<.01	<.001	<.001
500	8/7/74	5443	83	0.45	8226.2	21.4	0.14	0.03	2.2	0.15	0.01	0.04	<.001	<.001
13N 30E 34BD	January--------Ice Cover													
Flatwillow @ FAS 500	7/1/74	1096	47	----	1853.2	3.2	------	----	0.26	0.07	<.01	<.01	<.001	<.001
14N 30E 33CB	8/7/74	2680	4.0	0.63	4119.8	9.6	0.17	0.03	0.55	0.05	0.01	0.02	<.001	<.001
	9/9/74	1600	18.0	----	2596	5.4	0.02	0.09	0.18	0.04	0.01	0.02	0.006	<.001
	1/6/75	2056	21.0	----	3445	4.4	0.58	----	0.54	0.04	<.01	<.01	<.001	<.001

All results in mg/l unless otherwise designated.
All constituents are Total Dissolved unless otherwise noted.
Fecal Coliforms expressed as number/100 ml.

Reference: Montana Water Quality Bureau.

Konizeski (1970) reports rainbow trout are caught as far east as Ryegate, but the Musselshell from Shawmut to its headwaters is best known for brown trout. Primarily due to temperature changes, the Musselshell becomes a warm water fishery downstream of Ryegate. The dominant sport fish being the channel catfish. Results of a Montana Fish and Game Survey (1970) on the South Fork (near Lennep and Martinsdale) showed brook and brown trout as the dominant sport fishes. North Fork survey yielded similar results. Small feeder streams were brook trout dominated. Benthic surveys (1970) of both forks indicate waters of high quality with the South Fork having higher benthic populations. Impact on the biota in this section of river is primarily caused from dewatering and silt.

Dendy samplers were placed in the Musselshell River at Mosby, Musselshell, Melstone, and Ryegate. Samplers are susceptible to covering by sediment. This sediment hinders normal benthic colonization, thus making Dendy samplers inappropriate for the lower Musselshell. Those samplers that were slightly successful indicated low populations of caddis flies, mayflies, and diptera at Musselshell and Ryegate. These insects generally indicate waters of good quality and oxygen content. The low numbers observed in the river indicate benthic populations are being depressed by unknown factor(s). The covering of samplers by sediment at Mosby and Melstone eliminated any diagnosis of the benthic populations.

A periphyton analysis on Table 28 shows the dominant genera and the stream's trophic status. This analysis shows that the Musselshell River (Harlowton) grades from a moderate enrichment to a stream of high nitrogen enrichment (Mosby). The flora reflects saline influence at Melstone and Mosby. Small streams such as Painted Robe had high salinity. The flora reflected moderate nutrient enrichment at: Flatwillow, Little Careless, and American Fork Creeks. A complete periphyton list is found in Appendix E.

Current biological investigations are not adequate to completely describe the health of the aquatic biota on the Musselshell River. However, it does appear that the River at Mosby is a biological desert.

Table 28

Periphyton Analysis* of Selected Stations in the Musselshell Basin, 1974.

Station/Date	Dominant Genera	Trophic Status
Musselshell upstream of Harlowton 9/13/74	Cladophora, Tolypothrix, Cocconeis, Epithemia, Rhoicosphenia	Moderate saline influence Moderate nutrient enrichment Average floral diversity
Musselshell River Melstone 11/20/74	Diatoma, Navicula, Nitzschia, Amphipleura, Sariella	Saline influence Nutrient enrichment
Musselshell River @ Mosby 10/22/74 USGS	Nitzschia, Chlamydomonas, Diatoma, Cyclotella, Synedra	Nitrogen rich environment Saline, unstable environment Poor floral diversity
Mosby 11/19/74 USGS	Diatoma, Nitzschia, Synedra, Navicula, Cyclotella	Nitrogen rich environment Saline, unstable environment Poor floral diversity
Mosby 12/17/74 USGS	Synedra, Navicula, Unknown, Epithemia, Diatoma	Nitrogen rich environment Saline, unstable environment Poor floral diversity
Big Elk Creek south of Two Dot 11/21/74	Cladophora, Stigeoclonium, Fragilaria, Synedra, Cocconeis	Slight nutrient enrichment Healthy diversity
American Fork Creek SE of Harlowton 9/13/74	Moss, Cladophora, Nostoc, Rhizoclonium, Stigeoclonium	Moderate nutrient enrichment Healthy diversity
Little Careless Creek NE of Harlowton 11/8/74	Synedra, Navicula, Nitzschia, Gomphonema, Diatoma	Moderate nutrient enrichment Slightly restricted flora
Painted Robe Creek	Cladophora, Rivularia, Synedra, Diatoma, Navicula	Extreme saline influence
Flatwillow Creek S of Mosby 9/9/74	Cladophora, Rhoicosphenia, Nitzschia, Synedra, Diatoma	Saline influence Moderate nutrient enrichment Flora influenced by reservoir

* Analysis by Dr. Loren Bahls, Environmental Quality Council. For complete species list see Appendix E.

XI. WASTE DISCHARGE PERMITS

The Montana State program of issuing discharge permits is operated under authority of the Montana Water Pollution Control Law. Statutory authority to apply and enforce state compliance schedules in state permits are Sections 69-4806(3), 4808.2(1)(f)(1) and (2), 69-4820, 69-4820.1, and 69-4823, Revised Codes of Montana, 1947. The applicable rule is existing MAC 16-2-14(10)-S11460, Montana Pollutant Discharge Elimination System (MPDES), Section (2)(b)(ii), effective March 8, 1974. Five municipal, two industrial, and five agricultural waste discharge permits have been issued by the state in the Musselshell Basin. One agricultural discharge permit is currently being processed; while five additional feedlots should be applying for waste discharge permits.

The U. S. Environmental Protection Agency (EPA) is also issuing waste discharge permits in Montana. At this time EPA has issued no permits for the Musselshell Basin.

All municipalities are expected to meet secondary treatment requirements by July 1, 1977. At this time, several municipalities have met the requirements or have submitted a compliance schedule.

Effluent characteristics are presented in Table 6, Permit numbers and location of dischargers are presented in Table 29.

Federal permits are issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, Montana was given the authority to administer the NPDES program in Montana on June 10, 1974. Section 402 of the FWPCAA of 1972 provides that states with adequate water pollution control program elements may apply for and receive authority from the EPA to issue permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 Legislative Session to provide the statutory authority for administration of the aforementioned NPDES program in Montana. In addition, the Department of Health and Environmental Sciences adopted a rule entitled the Montana Pollutant Discharge Elimination System (MPDES). The MPDES rule provides the additional program elements needed by the state to comply with rules and regulations promulgated by the administrator of EPA pursuant to Section 304(h) of the FWPCAA of 1972. Section 304(h) related to the state program elements necessary to administer the NPDES program.

Table 29

Musselshell Waste Discharger's Location, Permit Number, and Compliance Schedule.

MUNICIPAL	MPDES Number	Location and Receiving Waters	Compliance Schedule
Broadview	MT 0020770	04N 23E 16 Dry Coulee	
Harlowton	MT 0020354	08N 15E 26 Musselshell River	June 1, 1977
Judith Gap	Septic Tanks		
Grass Range	No Discharge		
Lavina	Discharges during irrigation season.		
Martinsdale	Septic Tanks		
Melstone	MT 0020427	10N 31E 32 Musselshell River	
Musselshell	Septic Tanks		
Ryegate	MT 0020451	No Discharge	
Roundup	MT 0021652	No Discharge	
Winnett	MT 0020702	14N 27E 06 McDonald Creek	July 1, 1977
AGRICULTURAL			
Joseph Pease	F-29-B	Melstone 10N31E31	
Roundup Cattle Feeders	F-31-B	Roundup	
Joseph Spear Estate	MT 0029019	Roundup 08N25E36	
Heiken Land & Livestock Co.	MT 0023469	Lavina 05N22E09	
Madox Land & Cattle Co.	MT 0022764	05N23E19	
Ross Ranch	Application	Judith Gap 10N18E20	
INDUSTRIAL	MPDES Number	Location and Receiving Waters	Compliance Schedule
J. Burns Brown Well No. 11-2	MT 0022691	Shawmut - discharges to Mud Creek	
Milwaukee Railroad	MT 0000400	Harlowton	January 31, 1976
[illegible] Fuel Refinery	No Discha[illegible]e	Mosby	

XII. WASTE LOAD ALLOCATION

To prevent point source wastes from exceeding Montana's stream standards, loads to streams are allocated including an allowance for possible future changes in wastes and stream quality. All streams in the basin are designated effluent limited except the following segments that are designated as water quality limited:

1. Painted Robe Creek - entire stream
2. North Willow Creek - entire stream
3. Mud Creek - entire stream
4. Yellowwater Creek - entire stream
5. Big Coulee - entire stream
6. Careless Creek - from Deadman Reservoir to Musselshell River.

All the preceding streams designated as water quality limited presently are classified by the State of Montana as B-D3 streams. The designation of B-D3 indicates the stream is suitable for propagation and growth of non-salmonid fishes. Painted Robe Creek and Big Coulee (Table 10) have severe problems with salinity. They also have high temperatures and large amounts of total suspended solids. There are no point source discharges to these streams and sources of salinity have not been identified; thus, no waste load allocation can be made for these streams. North Willow Creek also has significant salinity problems (Table 7) as does Yellowwater Creek (Table 26). These streams do not receive any point discharges of waste but do receive some return flows from irrigation. The characteristics of these irrigation return flows and their impact on the streams have not been determined; therefore, presently no waste load allocations for these streams can be made. Additional data on the source of salinity in these streams is needed to determine if the salinity can be controlled. Mud Creek suffers from high salinities, suspended sediment, and temperatures. The J. Burns Brown industrial facility at Shawmut has a permit to discharge wastewaters into Mud Creek. This industrial facility, however, has not been discharging any water to Mud Creek. The waste discharge permit on file with the State of Montana for this facility indicates a total salinity of their discharge of approximately 4,219 mg/l as NaCl. Mud Creek is a saline stream and the impact of this wastewater on the stream is unknown. Additional testing of the stream and the industrial discharge is needed before it can be concluded whether a waste load allocation is necessary.

Careless Creek downstream from the Deadman's Reservoir has substantial problems with sediment, nutrients, bank instability, salinity, and coliform organisms. Much of this problem is caused by irrigation return flows into the Careless Creek stream. There are no point source discharges entering Careless Creek, and the nonpoint discharges that enter Careless Creek have not been thoroughly examined. Some nonpoint discharges are known to be subsurface and some are known to be surface discharges. One problem with the Careless Creek drainage is that water release from Deadman's Reservoir are hydraulically in excess of the streams capacity and

bank erosion occurs. Until the Careless Creek problem is further examined, no waste load allocation is possible.

XIII. MUNICIPAL FACILITY NEEDS AND INVESTMENTS

The upgrading of Harlowton's lagoon would be the basin's costliest project. It is estimated that these improvements would cost $175,000. Lavina should be encouraged to improve wastewater facilities. During some irrigation seasons, this community discharges raw sewage into the Musselshell River. The following is a list of community needs and investments:

Harlowton - one-cell lagoon, 21.5 acres, discharging to the Musselshell River via a small creek. Estimated cost to upgrade is $175,000. Problem is basically caused by infiltration; due to bacteria, chlorination needs to be evaluated.

Ryegate - two-cell lagoon, no discharge has been observed. Estimated cost to upgrade is $20,000.

Lavina - two-cell lagoon, 2 acres. During summer months, raw sewage is discharged to the Musselshell River. Problem is created by irrigation waters infiltrating the sewer system.

Roundup - one-cell, 16-acre lagoon, appears to be in need of maintenance, no discharge has been observed. Facility appears to be adequate for future needs.

Melstone - two-cell, 3 acres; this lagoon should provide complete retention; otherwise, it will discharge directly to the Musselshell River.

Winnett - two-cell, aerated lagoon which discharges to McDonald Creek. BOD is not a problem; however, chlorination may be required.

Judith Gap - septic tank system with no problems being recorded. Judith Gap is eligible for grant; estimated cost of lagoon construction is $60,000.

Grass Range - two-cell, 2.50 acre lagoon, no discharge has been reported. It is located on the South Fork of McDonald Creek. This lagoon probably will never discharge.

Musselshell - septic tank system. with no problems being recorded.

Martinsdale - septic tank system, with no problems being recorded.

Broadview - two one-acre lagoons which act as seepage ponds; effluent from this facility flows to a depression and not to a water body. Estimated cost to upgrade this system is $20,000.

The FY 75 priority list (Table 30) shows that Harlowton is the only basin community eligible for funding at this time.

TABLE 30. STATEWIDE PRIORITY LIST FOR CONSTRUCTION GRANTS PROGRAM

Community	Stream Segment	Water Use	Population Served	Scope of Project	Phase Construction	Total Points
Three Forks	6	6	2	30		94*
Whitefish (Birch Point)	8	6	2	15		81*
Missoula	8	6	3	30	30	77
Three Forks	6	6	2	30	30	74
Flaxville	6	2	1	15		74*
Great Falls	4	4	3	30	30	71
Victor	6	6	1	40		53
Miles City	6	2	2	40		50
Poplar	6	2	2	40		50
Billings Sixth Ave. No. Int.	4	2	3	40		49
Glasgow	4	2	2	40		48
Whitefish	8	6	2	30		46
Gallatin Co. RID 305	8	6	2	30		46
Bozeman	8	4	3	30		45
Bigfork	8	6	1	30		45
Livingston	6	6	2	30		44
Dillon	6	6	2	30		44
Libby	6	6	2	30		44
Hamilton	6	6	2	30		44
Red Lodge	6	6	2	30		44
Townsend	6	6	2	30		44
Thompson Falls	6	6	2	30		44
Boulder	6	6	2	30		44
Eureka	6	6	2	30		44
Columbus	6	6	2	30		44
Whitehall	6	6	2	30		44
Butte	8	2	3	30		43
Stevensville	6	6	1	30		43
Manhattan	6	6	1	30		43
Lodge Grass	6	6	1	30		43

(1) Montana Water Pollution Control Program Plan, June 15, 1974.
*Projects certified but not funded during the fiscal year received additional 50 points.

Community	Stream Segment	Water Use	Population Served	Scope of Project	Phase Construction	Total Points
Sheridan	6	6	1	30		43
Sunburst	6	6	1	30		43
Absarokee	6	6	1	30		43
Darby	6	6	1	30		43
Ennis	6	6	1	30		43
East Glacier	6	6	1	30		43
Roberts	6	6	1	30		43
Hobson	6	6	1	30		43
Bearcreek	6	6	1	30		43
Lewistown	6	4	2	30		42
Laurel	6	4	2	30		42
Hardin	6	4	2	30		42
Harlowton	6	4	2	30		42
Browning	6	4	1	30		41
Chester	6	4	1	30		41
St. Ignatius	6	4	1	30		41
Valier	6	4	1	30		41
Brady	6	4	1	30		41
Judith Gap	6	4	1	30		41
Rocker	8	2	1	30		41
Ramsay	8	2	1	30		41
Sidney	6	2	2	30		40
Forsyth	6	2	2	30		40
East Helena	6	2	2	30		40
Circle	6	2	1	30		39
Big Sandy	6	2	1	30		39
Hot Springs	6	2	1	30		39
Rocky Boy	6	2	1	30		39
Gildford	6	2	1	30		39
Malta	4	2	2	30		38
Warm Springs	4	2	2	30		38
Fromberg	2	4	1	30		37
Missoula Sewers	8	6	2	15		31
Whitefish Sewers	8	6	2	15		31
Kalispell Evergreen	8	6	2	15		31
Belgrade	8	6	1	15		30
Lakeside	8	6	1	15		30
Willow Creek	8	6	1	15		30
Amsterdam-Churchill	8	6	1	15		30
Bozeman Sewers	8	4	2	15		29

Community	Stream Segment	Water Use	Population Served	Scope of Project	Phase Construction	Total Points
Dillon Sewers	6	6	2	15		29
Plains	6	6	2	15		29
Troy	6	6	2	15		29
Anaconda-West Valley	6	6	2	15		29
Livingston Sewers	6	6	1	15		28
Opportunity	6	6	1	15		28
Ulm	6	6	1	15		28
Lolo	6	6	1	15		28
Sheridan Sewers	6	6	1	15		28
Corvallis	6	6	1	15		28
Clyde Park	6	6	1	15		28
Melrose	6	6	1	15		28
Martinsdale	6	6	1	15		28
Basin	6	6	1	15		28
Great Falls Sewers	4	4	3	15		26
Butte Sewers	8	2	1	15		26
Lewistown Sewers	6	4	1	15		26
Conrad	6	4	1	15		26
St. Ignatius Sewers	6	4	1	15		26
Helena Sewers	6	2	2	15		25
Helena Valley	6	2	2	15		25
Fort Benton	6	2	2	15		25
Ashland	6	2	2	15		25
Lincoln	2	6	2	15		25
Billings Sewers	4	2	3	15		24
Miles City Sewers	6	2	1	15		24
Sidney Sewers	6	2	1	15		24
Roundup Sewers	6	2	1	15		24
Stockett	2	6	1	15		24
Simms	2	6	1	15		24
Geyser	6	2	1	15		24
Havre Sewers	4	2	2	15		23
Billings Heights	4	2	2	15		23
Huntley	4	2	1	15		22
Great Falls Storm Sewer Sep.	4	4	3	10		21
Fairfield	2	2	1	15		20
Cut Bank Water Treatment	6	6	2	5		19

An acceptable application must be submitted within 90 days of notification by the department.

XIV. MANAGEMENT STRATEGY AND PLAN

The objective of water quality management is to maintain or enhance the quality of waters within the basin. To accomplish this, management programs and plans must be developed and implemented within the basin. After development and implementation, waters and wastewaters in the basin must be checked to determine actual effectiveness of the management program. Water quality management is an interactive process; that is, a plan must be followed, the results checked, the plan modified, and the results again checked. A management strategy contains a number of elements. These are:

1. Permits

   State and federal pollutant discharge permits are a basic tool in regulating the discharge of effluents to state waters. All discharges under the permit authority, either are or will be permitted or eliminated. The permit program regulates the quantity and quality of discharges of municipal and industrial wastes and certain agricultural wastes, including discharges from confined feeding operations and from irrigation drainage systems. The discharge permit also is used to regulate effluent from new or expanded discharges. As stream quality data are obtained, the permit can be used to insure that discharging effluents do not cause streams to exceed state water quality standards. All dischargers will be required, under the permit program, to achieve best practicable control technology not later than July 1, 1977. All publicly owned treatment works must achieve secondary treatment or any more stringent limitations necessary to meet water quality standards by July 1, 1977.

2. Intensive Surveys

   Intensive water quality surveys are conducted for waters in the basin that have water quality problems. Objectives of intensive surveys are to determine pollution causes and potential means of elimination or abatement of pollutants. As additional water quality problems are identified within the basin, intensive surveys will be made. Intensive surveys also are conducted to determine the impact of specific wastewater discharges, land practices, or water treatment facilities that are installed in the basin.

3. Monitoring

   Monitoring include a number of activities that provide measurement of chemical, physical and biological quality of water and changes in quality. Monitoring includes:

   (a) self-monitoring required by dischargers that are under the Pollutant Discharge Elimination System permit program;

(b) compliance monitoring by the Water Quality Bureau and the EPA to ensure that permitted discharges are in compliance with allowable limits;

(c) periodic sampling and analysis of water at selected stations;

(d) aerial and ground observations of basin waters and practices or facilities that effect water quality;

(e) the use of continuous water quality recording instrumentation to obtain a continuous record of selected water quality parameters;

(f) short-duration surveys of stream segments to determine changes in quality in streams as the water progresses downstream;

(g) evaluation of water quality data to determine trends and to identify problems.

The basic objective of the monitoring effort is to determine the status of water quality and to determine variations in water quality. The monitoring network also is useful for determining the impact of activities within the basin that influence water quality. Such activities include those that potentially degrade water quality, such as logging, mining, and certain agricultural practices; and those activities that may enhance water quality, such as installation of improved treatment facilities.

4. Facilities construction, operation, and maintenance.

Federal and state grant programs are available to assist municipalities in the construction of sewage treatment facilities, which include outfall and interceptor sewers. Such facilities provide improved treatment of wastewaters and reduce the impact of wastewaters on the receiving water body. An integral part of the waste treatment facility program is adequate operation and maintenance of the facilities after construction is completed. The state requires that all operators be certified and the state provides on-the-job training and annual schools for operators.

5. Operation and maintenance inspections.

Periodic inspections are made of municipal and industrial wastewater treatment facilities in the basin. The objective of operation and maintenance inspections is to ensure that waste treatment facilities are operated in a manner that provides the best possible treatment.

6. Information and Education.

Information is made available to the public through bureau publications, talks, technology transfer seminars, and through answering inquiries. Public hearings and environmental impact

statements are presented for important or controversial issues in the basin. Information and educational efforts are informing the public of water quality conditions in the basin and factors that can degrade water quality. This effort stresses development of a pollution prevention attitude.

7. Regulations and Guidelines.

To prevent water quality degradation within the basin, regulations and guidelines that relate to water quality will be made available to residents of the basin through state and county organizations. This includes regulations that influence water and wastewater from subdivisions and private and public water and wastewater facilities. In addition, existing regulations may be changed or updated to control activities within the basin that will degrade water quality. The Department of Health and Environmental Sciences in cooperation with other agencies, will develop guidelines that will abate or eliminate pollution resulting from storm drainage, storm sewer discharges and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices. Land use is recognized as a dominant factor controlling water quality in the basin. Those activities which influence land use will be examined to determine how water quality degradation due to improper land uses can be eliminated to be abated.

8. Enforcement.

Violations of Montana's laws, rules, or permits are investigated and are subject to injunction, civil penalties, or criminal penalties. The rules and regulations upon which enforcement is based are periodically reviewed and updated to insure that Montana's laws and regulations are adequate and can be properly enforced.

9. Program Coordination.

Montana's water pollution control program will be coordinated with other state, federal and local agencies to ensure that the activities of these groups receive adequate information with respect to their water quality related activities. This includes review of proposed programs, laws, regulations and proposed technical investigations that relate to water quality.

The elements of basin water quality management described above generally are applicable to all basins. Specific steps that will be taken in the Musselshell Basin are:

1. Permits.

Permit conditions and progress in meeting compliance schedules will be reviewed for all dischargers in the basin in FY 1976. All

permits will be reviewed prior to expiration to determine what revisions are needed for the reissued permits. All dischargers that have not received permits, but are under the NPDES or MPDES, will receive permits in FY 1976.

2. Intensive Surveys.

An intensive survey of the effects of Deadman's Basin discharge via Careless Creek to the Musselshell River. As additional water quality problems are identified and as funding is available, additional intensive surveys will be conducted.

3. Monitoring.

See Section XII (Monitoring and Surveillance) for specific basin strategy and plans.

4. Facilities Construction, Operation and Maintenance.

Inadequate municipal sewage treatment has been ranked according to priority (Page) and will be upgraded to meet secondary treatment as soon as federal construction grant monies are available. Industrial treatment of wastewater discharges will meet best practicable treatment at the latest by July 1977. Some EPA and state grant funds will be available for municipal sewage facilities. Sewage treatment plant operator training and the operators school will be available for the basin.

5. Operation and Maintenance.

At least one inspection will be made annually of each municipal sewage treatment facility in the Musselshell basin. Critical installations will be provided additional inspections when needed and facilities with special operation and maintenance problems will be provided with technical assistance.

Major industrial dischargers are examined at least twice per year and minor dischargers are examined as needed and as manpower and funding are available.

6. Information and Education.

The general bureau information and education program will be utilized in the basin. No specific basin programs are planned for the next year.

7. Regulations and Guidelines.

During the next year the regulatory framework for water pollution control will be reviewed by the bureau attorney. The adequacy of the regulations to prevent pollution will be assessed.

8. Enforcement.

Enforcement actions will be taken as needed for prosecution of violations of the state's water pollution laws and regulations.

9. Program Coordination.

Federal, state and private organizations that have water quality related actions in the basin will be informed of the Bureau's efforts and will be requested to furnish information on these basin programs.

Monitoring and Surveillance

Water quality monitoring and surveillance programs represent a major investment of time and funds. Such programs should obtain the needed information, at least cost. To properly design a cost-effective monitoring system, a number of factors must be considered including:

1. Adequacy of baseline data in the basin;
2. Status of the stream as a receiving water for pollutant discharges;
3. Data needs for point source discharges under state and federal permit programs;
4. Existing and potential water quality problems;
5. Data needs for enforcement actions;
6. Available time and funding;
7. Existence of other water quality data collection programs in the area.

Flexibility in scope and intensity is an important aspect of a proposed program. A variety of factors can influence an area's water quality; these include industrial, municipal, and agricultural developments, federal and state regulations, and water transfers. With the range of developments that can occur in a basin, a long-term management strategy cannot be efficiently developed. Water quality surveillance and monitoring is directed at short-term conditions (up to five years in the future) and is revised annually.

Monitoring and surveillance recommendations are presented in this report. The detailed basin monitoring and surveillance program is developed by the Water Quality Bureau as part of the annual water pollution control program plan. Monitoring and surveillance activities are conducted by a variety of organizations including communities and industries, federal and state agencies, private individuals and organizations. Commonly, acute problems such as toxic conditions causing fish kills, oil spills, etc. are recognized by basin residents or persons working in the basin.

The following is the recommended monitoring program for the Mussellshell Basin.

1. Compliance Monitoring

   It is recommended that the following point discharges be checked by the Water Quality Bureau to check compliance with permit conditions.

Harlowton	Winnett

Suspended solids, BOD_5, fecal coliforms, and flow will be monitored in all municipal discharges.

Similarly, it is recommended that the following industrial discharge be monitored by the Water Quality Bureau to check compliance with permit conditions:

Milwaukee Railroad - Harlowton

Frequency and parameters to be monitored for irrigation return flows have not as yet been defined. Feedlots are basically designed as non-discharging facilities.

2. Self-Monitoring

All waste dischargers under MPDES permit are required to periodically sample and analyze their wastewater and report these results to the Bureau and the Environmental Protection Agency. The parameters to be monitored are specified in the conditions of the permit.

3. Water Quality Surveillance Network

The water quality surveillance network is composed of water quality sampling stations on streams, waterbodies, and groundwater. Surveillance is recommended for the Musselshell at sites listed on Table 31.

Surveillance should also be conducted at Careless Creek, American Fork, Swimming Woman Creek and Flatwillow Creek.

Recommended surveillance frequency varies from continuously to quarterly and parameters to be monitored generally include flow, sediment, temperature, nutrients, common ions, and coliform organisms.

The actual basin surveillance program is described in the bureau annual water pollution control program plan. Details of sampling frequency and parameters also are described in this plan.

Biological assessment and water quality runs will be carried out at selected sites in the basin. Biological assessments involve periodic quantitative and/or qualitative benthic organism assessments. Water quality runs involve an intense instream survey of a few water quality parameters at a large number of stations. The sampling is designed to measure changes in stream quality as the water moves downstream. Sites selected for these evaluations are described in the Bureau's annual pollution control plan.

Table 31

Recommended Musselshell Water Quality Surveillance Stations

Station Name	Agency	Location	Sampling Interval	Water Quality Parameter(s)
Mosby	USGS	14N 30E 02AB	Monthly	Common Constituents, Dissolved Metals, Nutrients, Bacteria, Periphyton
Roundup	WQB	08N 25E 22CD	Quarterly	DO, Ca, Mg, Na, SO_4, Cl, S.S., Nutrients, S.C., Temperature, pH, Alkalinity, Flow
Harlowton	WQB	08N 15E 23BB	Quarterly	DO, Ca, Mg, Na, SO_4, Cl, S.S., Nutrients, S.C., Temperature, pH, Alkalinity, Flow
Mosby	WQB	14N 30E 02AB	Yearly	Benthos
Bundy	WQB	06N 23E 01DA	Yearly	Benthos
Delphia	WQB	09N 28E 28CB	Yearly	Benthos

Reference: Water Quality Bureau

4. Aerial and Ground Surveys

Examination of streams and water bodies is done as part of the routine bureau visits to the basin. Other agencies and organizations also commonly notice stream conditions during their basin trips. Detailed aerial surveillance and actual stream examination on foot or by boat is required for selected problems. Careless Creek should be examined in detail.

5. Data Interpretation and Analysis

Surveillance and monitoring activities develop water quality data that must be compared with previous data, water quality standards, permit conditions, etc. Results of water quality testing must be analyzed and interpreted to understand temporal and spatial changes in water quality and determine if the sampling network is adequate to meet program objectives.

6. A summary of present and potential water quality problems is presented on Table 32. This table provides a needed synopsis on basin-wide problems and it can be updated through the surveillance and monitoring program.

Table 32

Summary of Present and Potential Water Quality Problems in the Musselshell River Basin

SITUATION	LOCATION	STATUS	POTENTIAL FOR CORRECTION	METHOD OF CORRECTION
Waste oil on grounds near Milwaukee RR	Harlowton Musselshell River	Needs further investigation to determine if oil reaches stream	Questionable	Insure runoff doesn't reach the Musselshell
Municipal discharge, High BOD, S.S. and bacteria	Harlowton Musselshell River	Consulting firm has been contacted for corrective procedures	Good	Facilities to achieve compliance to be installed by March, 1977
Engine washings and oil from Milwaukee Railroad	Harlowton Discharges to small stream	Presently being treated by link belt separator	Railroad currently not meeting permit conditions	Facilities to achieve compliance to be installed in March, 1976
Sawmill is placing slash on banks and burning the slash. Waste is washed into Musselshell River	Roundup Half Breed Creek	Organization has been asked to correct situation, but to date this hasn't been accomplished	Good	Cease placing slash where it will enter creek
Septic tank overflow at meat packing house	Roundup Musselshell River	Organization has been asked to correct situation	Good	Make necessary repairs to prevent the seepage from reaching the river
Reports of raw domestic sewage entering stream	Near Roundup Half Breed Creek	This situation needs further investigation	Questionable	Utilize or repair the septic tank system
Municipal discharge emanating from aerated lagoon - effluent high in bacteria	Winnett McDonald Creek	Plans have been discussed to enlarge the lagoon	Good	Eliminate discharge or chlorinate effluent

Table 32
(continued)

SITUATION	LOCATION	STATUS	POTENTIAL FOR CORRECTION	METHOD OF CORRECTION
Irrigation makeup water from Deadman's Basin. Waters are high in sediments, nitrates and salts.	Careless Creek near Ryegate	Poor	Poor	Concrete canal and/or apply sound conservation practices to surrounding lands.
Saline seep problem is moderate to moderately severe	Many area streams are effected, e.g., Yellow Water, Box Elder, North Willow, Big Coulee, Painted Robe Creeks	Poor	Research is currently underway; however, corrective measures are in conflict with resource exploitation	Suitable conservation and cropping measures must be developed to suit Montana's alkali soils
Salt accrual in the Musselshell Basin	Most pronounced at Mosby	Poor	Water usage is in conflict with the streams health and potential for correction is poor	Sound water management practices must be developed to protect state waters and valuable agricultural lands
Suspended sediment problems are moderate to severe partially due to natural terrain, spin-off from saline seep and irrigation return flows	Careless Creek and other area streams	Poor to Fair	Fair-situation depends on developing better water management and conservation practices	Sound management practices of water and lands must be employed
Dewatering of streams due to irrigation and potential coal development	American Fork and other small streams	Fair	Protection of aquatic resources is in conflict with water usage	Questionable
Erosion potential severe due to logging at headwaters	Tyler Fork Creek near Forest Groove	Individual responsible has been contacted by WQB officials	Fair to good	Remove slash from stream, plant ground cover and restore normal drainage

XV. EXISTING AND FUTURE PLANNING NEEDS

The community of Harlowton has applied for and received a grant to prepare a 201 facility plan. It is recommended that the community of Lavina apply for a 201 grant. During the irrigation season, this community's wastewater system has excessive infiltration from high groundwater. This infiltration often causes raw sewage to be discharged to the Musselshell River.

The Musselshell River acts as the northwest border of Rosebud County. This county and five non-basin counties have received funding as the Yellowstone-Tongue Area 208 Planning Organization. The area of concern for Rosebud County lies in the Yellowstone basin and is discussed more thoroughly in the Middle Yellowstone Basin Plan (R. Karp and M. Botz, 1975).

The 208 act provides for two-year study completion and 100 percent federal funding and local control. It is hoped that these plans will accomplish three important things: (1) the water quality will be maintained or improved; (2) provide needed local input and control; (3) secure benefits of multi-county participation and the preparation of workable plans.

Considerable additional work is needed to better define basin water quality problems. The following list indicates, in order of priority, major water quality investigations needed in the basin.

1. Salinity, sediment and nutrients in Deadman's Basin, Careless Creek and the Musselshell River below Careless Creek.

2. Basin-wide impact of land use changes on water quality.

3. Impact of stream dewatering on water quality.

4. Evaluation of saline seeps on water quality.

5. Impact of basin logging operations on stream quality.

6. Salinity problems in Painted Robe, Mud, North Willow, Yellow Water and Big Coulee Creeks.

7. Impacts of septic tanks on streams.

XVI. PUBLIC HEARING

The public hearing for the Water Quality Inventory and Management Plan for the Musselshell River Basin, Montana was held at Harlowton, Montana at 7:00 p.m. on March 16, 1976. The hearing notices were placed in local newspapers as required by the Montana Administrative Act. The hearing was announced on the radio in the area and announcements of the hearing were sent to all persons and organizations that were thought to be interested in the hearing.

Mr. Alf Hulteng, Water Quality Bureau, opened the hearing by explaining the purpose of the plan. Mr. Jerry Kaiser (Water Quality Bureau), who had done the principal work on the plan, explained various portions of the plan.

Concerns voiced by the audience covered the following topics: Overgrazing on federal land, poor oil and gas drilling practices and logging effects. Opinions were expressed toward better differentiating of non-point sources. Other statements were oriented towards objections of taxes, possible land use laws and poor advertising of the hearing.

A complete transcript of the hearing is available for the Water Quality Bureau.

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APPENDIX A

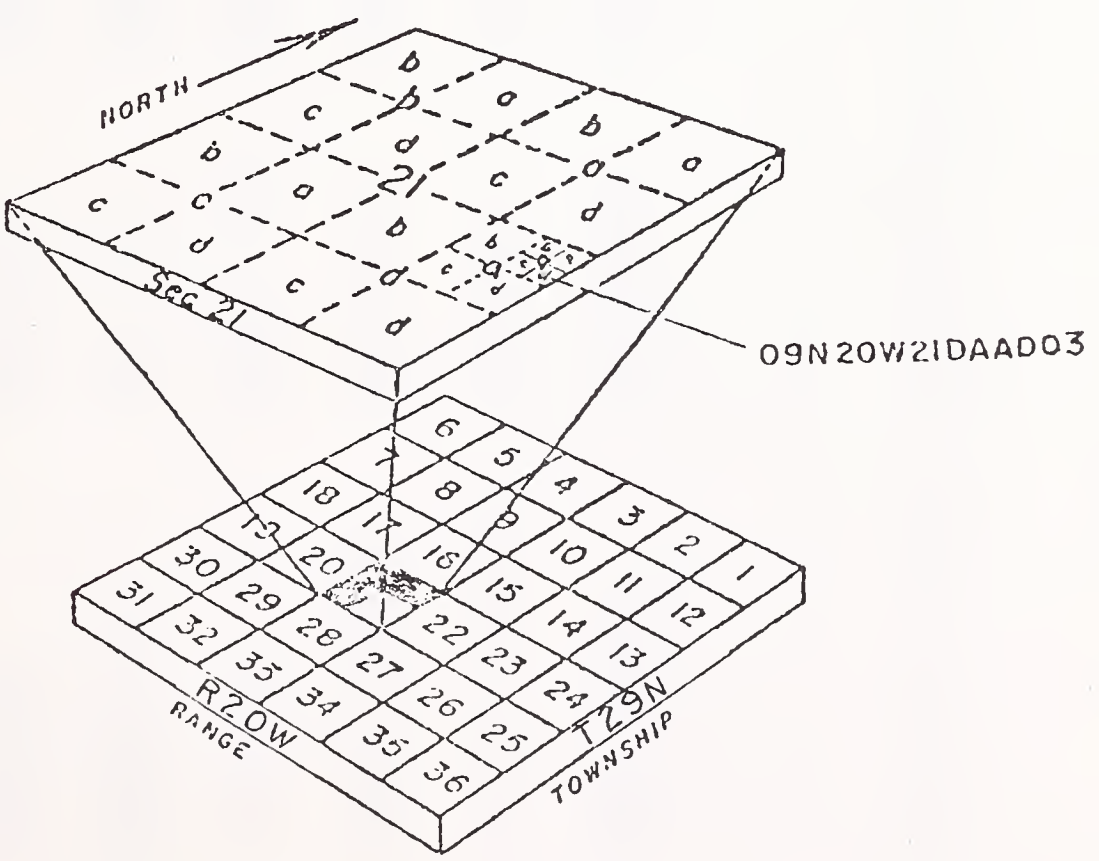
GLOSSARY

Symbol	Definition
BOD_5	Five-day biochemical demand
cfs	Cubic feet per second
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
JTU	Jackson turbidity unit
lbs/capita/day	Pounds per capita per day
lbs/day	Pounds per day
ml	Milliliter
mgd	Million gallons per day
mg/l	Milligrams per liter
sq. ft.	Square feet
TR	Total recoverable
tpd	Tons per day
μmhos	Micromhos per centimeter
$<$	Less than
$\leq$	Less than or equal to
$\geq$	Greater than or equal to
$\sim$	Approximately
BPT	Best practical treatment
WQB	Montana Department of Health & Environmental Sciences, Environmental Sciences Division, Water Quality Bureau
F & G	Fish and Game, Montana Department of
MDHES	Montana Department of Health & Environmental Sciences
MPDES	Montana Pollutant Discharge Elimination System
NPDES	National Pollutant Discharge Elimination System
BuRec	Bureau of Reclamation
EPA	U. S. Environmental Protection Agency
NOAA	National Oceanographic and Atmospheric Administration
SCS	U. S. Department of Agriculture, Soil Conservation Service.
USGS	U. S. Geological Survey
USPHS	U. S. Public Health Service

APPENDIX B

SYSTEM FOR GEOGRAPHICAL LOCATION OF FEATURES

Features such as water sampling sites, wells, and springs are assigned a location number that is based on the system of land subdivision used by the U. S. Bureau of Land Management. The number consists of fifteen characters and describes the location by township, range, section and position within the section. The figure below illustrates this numbering method. The first three characters of the number give the township, the next three the range. The next two numbers give the section number within the township, and the next four letters describe the location within the quarter section (160-acre tract), and quarter-quarter section (40-acre tract), and a quarter-quarter-quarter section (10-acre tract), and the quarter-quarter-quarter-quarter (2 1/2-acre tract). These subdivisions of the 640-acre section are designated as A, B, C, and D in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one feature in a 2 1/2-acre tract, consecutive digits beginning with the number 02 are added to the number. For example, if a water quality sample was collected in Section 21, T29N, R20W it would be numbered 29N20W21DAAD02. The letters DAAD indicate that the well is in the southeast 1/4 of the northeast 1/4 of the northeast 1/4 of the southeast 1/4, and the number 02 following the letters DAAD indicates that there is more than one site location in this 2 1/2-acre tract.



APPENDIX C

Reservoirs Located in Musselshell River Basin Which Influence Flows of the Musselshell River

NAME	WATER SOURCE	LOCATION	YEAR OF COMPLETION	STORAGE MAXIMUM	ACRE FEET MINIMUM
Martinsdale Reservoir	South Fork Musselshell	Wheatland County 08N 12E 18	1939	22,920	---
Bair Reservoir (Durand)	North Fork Musselshell	Meagher County 10N 09E 35	1939	7,060	1,140
Lebo Lake	American Fork Creek	Wheatland County 07N 13E 36 & 31	1965	4,255	
Deadman's Basin	Musselshell River	Wheatland County 07N 18E 25	1941	63,970	3,290
Petrolia Reservoir	Flatwillow Creek	Petroleum County 14N 27E 36	1951	9,192	
Yellow Water Creek Reservoir	Yellow Water Creek	Petroleum County 13N 26E 07	1939	4,400	---

Records from Montana Department of Natural Resources.

APPENDIX C

DESCRIPTIONS OF THREE MAJOR RESERVOIRS WHICH INFLUENCE FLOWS OF THE MUSSELSHELL RIVER.

06122500 DEADMAN'S BASIN RESERVOIR--Lat 46°20'24", long 109°24'35", in NE 1/4 sec.25, T.7 N., R.18 E., Wheatland County, at dam 6 mi (9.7 km) east of Shawmut. Period of record, June 1941 to June 1955 (some contents may be total), July 1955 to current year (usable contents), incomplete 1942, 1951-59. Nonrecording gage read at or near middle and end of month. Datum of gage is at mean sea level (levels by Montana Department of Natural Resources and Conservation).

Extremes for current year: Maximum contents observed, 69,150 acre-ft (85.3 hm^3) Apr. 30, May 16 (elevation, 3919.5 ft or 1,194.66 m); minimum, 10,300 acre-ft (12.7 hm^3) Aug. 15 (elevation, 3883.5 ft or 1,183.69 m). Extremes for period of record: Maximum contents observed, 72,420 acre-ft (89.3 hm^3) June 15, 1967 (elevation 3,921.1 ft or 1,195.15 m); minimum observed, 3,290 acre-ft (4.06 hm^3) Oct. 31, 1961 (elevation, 3867.3 ft or 1,178.75 m).

This is an offstream reservoir formed by earthfill dam completed in 1941. Stored water is diverted from Musselshell River in NW 1/4 sec.8, T.7 N., R.17 E., 6 mi (9.7 km) northwest of Shawmut. Usable capacity, 72,220 acre-ft (89.0 hm^3) between elevation 3,872.0 ft (1,180.19 m), bottom of outlet, and 3,921.0 ft (1,195.12 m), maximum design level. Prior to 1958, usable capacity was 52,500 acre-ft (64.7 hm^3) at elevation 3,911.0 ft (1,192.07 m). Dead storage, 4,600 acre-ft (5.67 hm^3) below elevation 3,872.0 ft (1,180.19 m). Figures given herein represent usable contents. Water is used for irrigation. Records furnished by Montana Department of Natural Resources and Conservation.

06116500 BAIR RESERVOIR--Lat 46°34'24", long 110°33'24", in S 1/2 sec.35, T.10 N., R.9 E., Meagher County, at dam on North Fork Musselshell River, 1 mi (1.6 km) northwest of Delpine and 14 mi (23 km) northwest of Martinsdale. Drainage area, 48.6 mi^2 (126 km^2). Period of record, November 1939 to September 1960 [total contents, winter records incomplete some years during 1951-59, October 1960 to current year (usable contents)]. Records for November 1939, published as "Durand Reservoir." Nonrecording gage read at or near middle and end of month. Datum of gage is at mean sea level (levels by Montana Department of Natural Resources and Conservation).

Extremes for current year: Maximum contents observed, 5,210 acre-ft (6.42 hm^3) May 21 (elevation 5,317.6 ft or 1,620.80 m); minimum observed, 2 acre-ft (2,470 m^3) Sept. 28 (elevation 5,253.6 ft or 1,601.30 m). Extremes for period of record: Maximum contents observed, 7,150 acre-ft (8.82 hm^3) June 15, 1967 (elevation, 5,325.5 ft or 1,623.21 m); no storage July 31, 1961.

Reservoir is formed by earthfill dam with concrete spillway completed in 1939. Usable capacity 7,000 acre-ft (8.63 hm^3) between elevation 5,253.2 ft (1,601.18 m), bottom of inlet, and 5,325.0 ft (1,623.06 m), spillway crest. Dead storage, 24 acre-ft (29,600 m^3) below elevation 5,253.2 ft (1,601.18 m). Supplemental water can be diverted from Checkerboard Creek in S 1/2 sec.5, T.9 N., R.9 E., but seldom used. Figures given herein represent usable contents. Water is used for irrigation. Records furnished by Montana Department of Natural Resources and Conservation. Revisions, WSP 1729: Drainage area.

06119000 MARTINSDALE RESERVOIR--Lat 46°27'17", long 110°16'02", near center of sec.18, T.8 N., R.12 E., Wheatland County, at north dam 2 mi (3.2 km) east of Martinsdale, lat 46°26'33", long 110°15'30", in NE 1/4 sec.20, T.8 N., R.12 E., at south dam 3 mi (4.8 km) southeast of Martinsdale. Period of record, November 1939 to September 1960 (total contents), winter records incomplete for some years during 1951-59, October 1960 to current year (usable contents). Records for November 1939, published only in WSP 1309. Nonrecording gage read at or near middle and end of month. Datum of gage is at mean sea level (levels by Montana Department of Natural Resources and Conservation).

Extremes for current year: Maximum contents observed, 14,150 acre-ft (17.4 hm^3) June 1 (elevation, 4,768.5 ft or 1,453.44 m); minimum observed, 79 acre-ft (97,400 m^3) Aug. 16 (elevation, 4,718.7 ft or 1,438.26 m). Extremes for period of record: Maximum contents observed, 22,920 acre-ft (28.3 hm^3) July 1, 1965 (elevation, 4,778.8 ft or 1,456.58 m); no storage July 31, Aug. 31, Sept. 30, Oct. 31, 1961.

This is an offstream reservoir formed by two earthfill dams with concrete conduit and spillway completed in 1939. Stored water is diverted from South Fork Musselshell River in N 1/2 sec.15, T.8 N., R.11 E., at a point 1 mi (1.6 km) west of Martinsdale. Usable capacity, 23,110 acre-ft (28.5 hm^3) between elevation 4,714.67 ft (1,437.03 m), bottom of outlet, and 4,779.0 ft (1,456.64 m), spillway crest. Dead storage 73 acre-ft (90,000 m^3) below elevation 4,714.67 ft (1,437.03 m). South Fork Musselshell River flow above diversion is supplemented at times with return

flow from lands irrigated by water diverted from North Fork Musselshell River. Figures given herein represent usable contents. Water is used for irrigation. Records furnished by Montana Department of Natural Resources and Conservation.

APPENDIX D

Musselshell Basin Irrigation Systems

Drainage Basin	
40A	Lake Lebo Irrigation Company
	Upper Musselshell Water Users Association
	Deadman's Basin Water Users Association
	Lavina Water Users Association (Mutual) Deadman's Basin Water Users
40B	Flatwillow Including Box Elder Creek
	Petrolia Water Users Association
	Yellow Water Users Association
	Winnett Irrigation Company
40C	Musselshell River downstream of Roundup
	Delphia-Melstone Canal Users Association

Reference: Oil and Hazardous Materials Pollution Control Contingency Plan. 1974. Water Quality Bureau, State of Montana, pp. 1-149.

APPENDIX E

Periphyton Analysis from Selected Sites in the Musselshell River Basin.

I. American Fork Creek East of Harlowton, Periphyton, 9/13/74.

Nitzschia fonticola 0.3, Amphipleura pellucida, Diatoma tenue v. elongatum 0.3, Synedra acus, Epithemia sorex 26.3, E. zebra v. saxonica 3.2, Cocconeis pediculus 4.8, Cymbella ventricosa 1.6, Gyrosigma acuminatum, Diatoma vulgare 0.9, Rhoicosphenia curvata 5.4, Synedra ulna 7.0, Cocconeis placentula v. euglypta 13.0, Gomphonema constrictum, Fragilaria sp., Meridion circulare, Surirella angustata 0.9, Rhopalodia gibba 0.3, Navicula tripunctata 0.6, N. cryptocephala 0.3, N. c. v. veneta 4.8, Nitzschia dissipata 4.1, Gomphonema acuminatum, Melosira varians, Nitzschia kutzingiana 2.5, Nitzschia sp. 0.6, Cymatopleura solea, Achnanthes linearis 0.3, Navicula pupula 0.3, Surirella ovata 0.3, Gomphonema olivaceum v. calcarea 0.6, Surirella ovata v. pinnata, Achnanthes minutissima 5.1, Cyclotella glomerata, C. meneghiniana 0.6, Synedra ulna v. amphirhynchus, Gomphonema parvulum, Nitzschia apiculata, Achnanthes deflexa, Navicula radiosa, Nitzschia romana, Gomphonema bohemicum 0.3, Nitzschia acuta 0.3, Cymbella affinis 0.3, Surirella sp., Nitzschia palea 3.5, Cymbella microcephala 0.3, Gomphonema olivaceum 9.5, Fragilaria vaucheriae 0.3, Navicula tripunctata v. schizonemoides 0.3, Achnanthes lanceolata.

II. Musselshell River above Harlowton, Periphyton, 9/13/74.

Rhoicosphenia curvata 8.5, Cocconeis pediculus 28.8, Cyclotella meneghiniana, Navicula cryptocephala 5.9, Nitzschia dissipata 6.8, N. amphibia, Cocconeis placentula v. euglypta 5.3, Epithemia sorex 22.1, Navicula viridula v. avenacea 0.3, Epithemia zebra v. saxonica 0.3, Achnanthes minutissima 1.5, Diatoma vulgare 2.1, Amphipleura pellucida, Rhopalodia gibba, Navicula tripunctata 2.4, Gomphonema olivaceum v. calcarea, Achnanthes lanceolata, Gyriosigma acuminatum, Synedra ulna v. danica 0.6, Nitzschia sigmoidea, Fragilaria sp., Navicula cryptocephala v. veneta 4.1, Amphora ovalis v. pediculus 3.2, Gomphonema parvulum 0.3, Cymbella sinuata 0.3, Cyclotella glomerata 0.3, Gomphonema olivaceum 2.9, Nitzschia recta 0.6, Fragilaria vaucheriae 0.3, Gomphonema sp., Nitzschia epiphytica 0.6, Gomphonema constrictum 0.3, Surirella ovata, Gomphonema bohemicum, Cymbella microcephala, Nitzschia apiculata, Synedra acus 0.6, Nitzschia palea 0.9, Caloneis bacillum (?) 0.3, Nitzschia gracilis 0.3.

III. Flat Willow Creek at FAS 500, Periphyton, 9/9/74.

Genus unk. 0.3, Cymbella sinuata 0.3, Rhoicosphenia curvata 16.0, Epithemia zebra v. saxonica 0.9, Rhopalodia gibberula 0.3, Achnanthes sp., A. minutissima 17.2, Gomphonema parvulum 3.2, Fragilaria crotonensis 5.2, F. construens v. venter, Diploneis elliptica 1.5, Diatoma tenue v. elongatum 8.4, Cyclotella glomerata 0.3, Rhopalodia gibba, Cocconeis pediculus 0.3, Synedra minuscula 18.4, Nitzschia

frustulum v. subsalina 7.9, Navicula heufleri v. leptocephala 0.3, Nitzschia dissipata 1.2, Navicula capitata v. hungarica 0.3, Nitzschia palea 7.9, Navicula cincta 0.9, N. sp. (1) 1.8, N. sp. (2) 0.6, Cyclotella meneghiniana 0.3, Nitzschia romana 0.3, Mastogloia smithii 0.6, Nitzschia sp., Cymbella affinis 0.3, Nitzschia hungarica, Navicula crypocephala v. veneta 0.3, Diatoma vulgare v. breve, Nitzschia acicularis 0.3, Amphipleura pellucida 0.9, Navicula sp. (3) 0.3, N. sp. (4), Amphora ovalis v. pediculus, Stephanodiscus astraea v. minutula, Navicula cryptocephala 0.6, Amphiprora alata, Cymbella microcephala 0.9, Cocconeis placentula 0.6, Gomphonema sp. 0.3, Nitzschia frustulum 0.3, Gomphonema olivaceum v. calcarea 0.3, Mastogloia sp. 0.3, Nitzschia tryblionella v. debilis 0.6.

IV. Little Careless Creek North of Harlowton, Periphyton, 11/8/74.

Nizschia sigmoidea, Surirella ovata 25.9, Nitzschia dissipata 7.5, Gomphonema olivaceum 15.9, Nitzschia palea 3.1, Neidium affine v. emphirhynchus 0.3, Navicula viridula v. avenacea 10.0, N. cryptocephala v. veneta 2.5, Achnanthes minutissima 0.9, Synedra ulna 1.9, Nitzschia kutzingiana 2.5, Cocconeis placentula v. euglypta 2.8, Diatoma tenue v. elongatum 0.3, Nitzschia gracilis 0.3, Amphora ovalis v. pediculus, Navicula cryptocephala 1.9, Rhoicosphenia curvata, Nitzschia recta 0.3, Navicula tripunctata 0.9, Nitzschia acuta 0.9, Surirella brightwellii 0.6, Gomphonema parvulum 0.3, Epithemia sorex, Surirella angustata, Gyriosigma acuminatum 0.3, Meridion circulare 0.3, Fragilaria vaucheriae 0.6, Cymatopleura solea, Nitzschia tryblionella v. levidensis, Caloneis amphisbaena, Nitzschia apiculata 0.3, Gomphonema constrictum, Cymbella sp., Nitzschia sublinearis 1.9, N. sp. 10.3, N. paleacea 2.5, Navicula sp. 0.3, Nitzschia romana 2.2, Gomphonema olivaceum v. calcarea 0.9, G. tergestinum 0.3, Nitzschia linearis 0.3, N. filiformis 0.9.

V. Painted Robe Creek Southeast of Lavina near Mouth, Periphyton, 11/21/74.

Synedra pulchella 0.6, Achnanthes linearis 0.3, A. minutissima 4.4, Amphipleura pellucida 0.9, Amphiprora alata 0.3, Amphora ovalis, Caloneis amphisbaena, C. ventricosa v. truncatula 0.3, Cocconeis placentula 0.3, Cyclotella meneghiniana 0.3, Cymbella parva 1.2, C. prostrata, C. ventricosa 0.3, C. sp. 0.6, Diatoma tenue v. elongatum 51.6, D. vulgare, Gomphonema intricatum, G. olivaceum v. calcarea, G. parvulum (?), G. sp., Gyrosigma sp., Mastogloia sp. 0.3, Navicula cryptocephala 0.3, N. c. v. veneta 3.8, Navicula halophila, N. peregrina, N. pygmaea, N. viridula, N. sp. (1), N. sp. (2), Nitzschia apiculata 0.3, N. communis, N. frustulum, N. frustulum v. subsalina 0.9, N. linearis, N. microcephala, N. palea 0.6, N. tryblionella, N. vitrea. Rhoicosphenia curvata 0.6, Rhopalodia gibba, R. gibberula, Surirella ovata 1.4, Sp. spiralis, S. striatula, Synedra fasciculata 28.4, S. minuscula 2.6

VI. Big Elk Creek South of Two Dot, Periphyton, 11/21/74

Achnanthes linearis 0.3, A. minutissima 10.9, Amphipleura pellucida 1.9, Amphora ovalis v. pediculus 3.0, Cocconeis pediculus 29.4,

C. placentula v. euglypta 16.4, Cyclotella meneghiniana 0.3, Cymatopleura solea, Cymbella affinis, C. microcephala 0.3, C. prostrata, C. sinuata 0.5, C. tumida, C. ventricosa 0.5, Diatoma vulgare 2.7, Epithemia argus 0.3, E. sorex 1.1, Fragilaria construens 0.3, F. sp. 2.7, Gomphonema bohemicum 0.8, G. olivaceum 6.8, G. o. v. calcarea 0.3, G. sp. 0.3, Gyrosigma sp., Melosira varians, Navicula cryptocephala 2.4, N. c. v. veneta 4.4, N. tripunctata 1.4, N. viridula v. avenacea 0.3, Neidium binode 0.3, Nitzschia dissipata 3.8, N. linearis 0.3, N. palea 1.9, N. paleacea 0.3, N. recta 0.5, N. sigmoidea, N. tryblionella (?) 0.3, Rhoichosphenia vurvata 1.6, Rhopalodis gibba, surirella angustata 0.5, S. ovalis 0.3, Synedra minuscula 0.5, S. ulna 2.4.

VII. Musselshell River at Melstone, Periphyton, 11/20/74.
(Sample to sparse to attempt proportional count - *common.)

*Achnanthes minutissima, Amphipleura pellucida, Amphiprora alata, Amphora ovalis, Cocconeis pediculus, C. placentula v. euglypta, *Cymbella microcephala, C. sinuata, C. ventricosa, Denticula sp., *Diatoma tenue, D. vulgare, Epithemia sorex, Fragilaria sp., Gomphonema olivaceum (?), Gyrosigma sp., *Navicula cryptocephala, *N. c. v. veneta, N. integra, N. pupula, N. viridula v. avenacea, *Nitzschia apiculata, *N. dissipata, Nitzschia palea, N. sigmoidea, Rhoicosphenia curvata, Surirella ovata, *Synedra ulna.

APPENDIX F

MONTANA STATE DEPARTMENT OF HEALTH
AND
ENVIRONMENTAL SCIENCES

MAC 16-2.14(10)-S14480 WATER QUALITY STANDARDS

(1) Policy statement. The following standards are adopted to establish maximum allowable changes in water quality and establish limits for pollutants which affect prescribed beneficial uses of state waters. The department adopts as a rule the policy that best practicable treatment and control of waste, activity and flow is to be provided to maintain dissolved oxygen and overall water quality at the highest possible levels, and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious substances at the lowest possible levels.

(2) Application of standards. The water quality standards are composed of water-use classifications [section (4)], water-use descriptions and specific water quality criteria [section (5)], and general water quality criteria [section (6)].

(a) General water quality criteria apply to all state waters except where in this rule specific water quality criteria are more applicable to a specific water-use classification.

(b) In order to carry out the objective of the rule, existing discharges to state waters shall be brought into compliance with the standards as soon as practicable, and in no case later than three years from the effective date of the rule.

(3) Definitions. Unless statutory definition or the context otherwise requires in this rule:

"Conduit" means any artificial or natural duct, either open or closed, for conveying liquids or other fluids.

"Dewatered stream" means a perennial or intermittent stream whose water has been removed for one or more beneficial uses.

"EPA" means the U. S. Environmental Protection Agency.

"Intermittent stream" means a stream or portion of a stream that flows only in direct response to precipitation; it receives little or no water from springs and no long-continued supply from melting snow or other sources.

"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from dams in existence as of July 1, 1971 are natural.

"Mixing zone" means that volume of state water wherein any pollutant may exceed allowable water quality standards.

"Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

"Residue" means oils, floating solids and sludge deposits.

"Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

"Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"State waters" means any body of water, irrigation system or drainage system, either surface or underground. This section shall not apply to irrigation waters where the waters are used up within the irrigation system and said waters are not returned to any other state waters. The term "state waters" as used in this rule does not include underground water.

"Storm sewer" or "storm drain" means a sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes sewage and industrial wastes.

"True color" means the color of water from which the turbidity has been removed.

"Turbidity" means a condition in water or wastewater caused by the presence of suspended matter resulting in the scattering and absorption of light rays.

(4) Water-use classifications.

MISSOURI BASIN

Missouri River Drainage

Musselshell River drainage to and including Hopley Creek near Harlowton . . . . . B-D_1

Musselshell River drainage from Hopley Creek to but excluding Half Breed Creek near Roundup except American Fork listed below B-D2

American Fork drainage . . . . . B-D_1

Musselshell River drainage from and including Half Breed Creek to Fort Peck Reservoir except Flatwillow Creek drainage listed below . . . . . B-D_3

Flatwillow Creek drainage (may be the Box Elder Creek drainage) near Mosby . . . . . B-D_2

(5) Water-use description and specific water quality criteria.

(d) B-D_1 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D_1 except for Prickly Pear Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 65° F; within the naturally occurring range of 65° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(e) <u>B-D_2 classification.</u>

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter from October 1 through June 1 nor below 6.0 milligrams per liter from June 2 through September 30.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(f) <u>B-D3 classification</u>.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 5.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 shall be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 77° F; within the naturally occurring range of 77° F to 79.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 80° F; and where the naturally occurring water temperature is 79.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D3, except from the Billings water supply intake to the water diversion at Intake, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 79° F; within the range of 79° F to 81.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 82° F; and where the naturally occurring water temperature is 81.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

From the water diversion at Intake to the North Dakota state line, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 82° F; within the range of 82° F to 84.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 85° F; and where the naturally occurring water temperature is 84.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(g) C-D_1 classification.

(i) Water-use description. The quality is to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers, and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 5.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 shall be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 77° F; within the naturally occurring range of 77° F to 79.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 80° F; and where the naturally occurring water temperature is 79.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D3, except from the Billings water supply intake to the water diversion at Intake, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 79° F; within the range of 79° F to 81.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 82° F; and where the naturally occurring water temperature is 81.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

(e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

(ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.

(iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.

(iv) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.

(v) Create conditions which produce undesirable aquatic life.

(f) No wastes are to be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards; (e.g., in a reach of stream classified B-D_1, the total allowable cumulative increase to naturally occurring turbidity conditions in the reach is 5 Jackson Candle Units).

(g) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause turbidities to exceed those allowed by specific water quality criteria; provided, short-term activities necessary to accommodate essential dredging, channel or bank alterations, stream diversions or other construction where turbidities in excess of the criteria are unavoidable, may be authorized by the department under conditions as it may prescribe.

(h) Methods of sample collection, preservation and analysis used to determine compliance with the standards are to be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association or in accordance with tests or procedures that have been found to be equally or more applicable.

(i) For operations of existing water impoundments that cause conditions harmful to prescribed beneficial uses of state waters, it is to be

demonstrated to the satisfaction of the department that continued operations will be done in the best practicable manner to minimize harmful effects and will not violate state laws or department rules. New water impoundments shall be designed to provide temperature variations in discharging water that maintain or enhance the existing propagating fishery and associated aquatic life. As a guide, the following temperature variations are recommended: Continuously less than 40° F during the months of January and February, and continuously greater than 44° F during the months of June through September.

(j) Ponds for waste treatment purposes are not to be located in drainage ways where the volume of drainage water from a 10-year storm entering the ponds exceeds one-half the volume of the pond; provided that, subject to approval by the department as to design and maintenance, ponds located in drainage ways for the express purpose of containing emergency oil spills are permitted.

(k) Dumping of snow from municipal and/or parking lot snow removal activities into waters of the state is prohibited without a permit from the department.

(l) Existing discharges to state waters will be entitled a mixing zone as determined by the department.

(m) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams are to be no less than the minimum treatment requirements prescribed.

(n) Treatment requirements for discharges to intermittent streams are to be no less than the minimum treatment requirements prescribed.

(o) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices, are to be eliminated or minimized as ordered by the department.

(p) Application of pesticides in or adjacent to state waters is to be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 27, Chapter 2, R.C.M. 1947) and the Federal Environmental Pesticides Control Act (Public Law 92-516). Excess pesticides and pesticide containers are not to be disposed of in a manner or in a location where they are likely to pollute state waters.

(q) The following radiological criteria shall apply to all waters except those classified as A-Closed:

(i) The average dissolved concentrations (including the naturally occurring or background contribution) of iodine 131, radium-226, strontium-89, strontium-90 and tritium are not to exceed the following concentration limits:

Iodine-131	5 pCi/L
Radium-226	1 pCi/L
Strontium-89	100 pCi/L
Strontium-90	10 pCi/L
Tritium	3,000 pCi/L

For all other radionuclides, the average dissolved concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water for continuous occupational exposure as recommended by the National Committee on Radiation Protection (National Bureau of Standards Handbook 69 or subsequent revisions.)

(ii) For a mixture of radionuclides, the following relationship is to be satisfied:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} \cdot \cdot \cdot + \frac{C_n}{L_n} \leq 1.00$$

C denotes the average concentration of the respective radionuclide, and L denotes its concentration limit.

(iii) Where alpha emitters, strontium-90, radium-228, iodine-129, iodine-130 and lead-210 are known to be absent, routine analyses for dissolved gross beta radioactivity (excluding potassium-40 contribution) may be employed to monitor and show compliance with this criterion (except for tritium) as long as the gross concentration does not exceed 100 pCi/L. When these conditions are not met, routine quantitative analyses of individual radionuclides are to be performed to show compliance. Except in cases where tritium from other than natural sources is known to be absent, routine tritium analyses are to be performed to show compliance. (Note: "Absence" means a negligibly small fraction of the specific concentration limit, where the limit for unidentified alpha emitters is taken as the limit for radium-226.)

(iv) For radionuclides associated with suspended material in transport, the average concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water (insoluble form) for continuous occupational exposure as recommended by the National Committee on Radiation Protection. In-stream sedimentation of these materials is not to produce solids beds that are not in compliance with subsections (q) (i) and (q) (ii) (because of leaching) and/or excessive accumulation in native flora and fauna.

(v) Average concentrations are to be computed from monitoring data acquired during the previous 12 months; maximum concentrations are not to exceed three times the average concentration limits specified.

(vi) Variances from concentration limits specified will be permitted only if the contributing source is non-controllable or a natural source. Best available treatment must be provided for man-made discharges, and the exposure received by affected population groups must be within established dose limits.

(r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.

(s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.

When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Administration (1968), or by using other methods accepted as equal or applicable by EPA.

(t) Metal limits for the Clark Fork River (mainstem) from the confluence of Warm Springs Creek to the confluence with Cottonwood Creek are:

Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	90	180
Dissolved copper	30	40
Total zinc	300	1,000
Dissolved zinc	80	140
Total iron	1,300	2,200
Dissolved iron	150	160
Total lead	100	100
Dissolved lead	100	100
Total cadmium	10	10
Total arsenic	10	16
Total mercury	1	1

Metal limits for Clark Fork River (mainstem) from the confluence of Cottonwood Creek to the Idaho state line are:

Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	50	90
Dissolved copper	30	30
Total zinc	100	200
Dissolved zinc	70	80
Total iron	300	1,300
Dissolved iron	150	150
Total lead	50	50
Dissolved lead	50	50
Total cadmium	10	10
Total arsenic	10	10
Total mercury	1	1

(History: Sec. 69-4814, R.C.M. 1947; IMP Sec. 69-4808.2(1)(b), R.C.M. 1947; Order MAC No. 16-1; Adp. 12/31/72; Eff. 12/31/72; AMD, MAC Notice No. 16-2-3, Order MAC No. 16-2-5; Adp. 7/13/73; Eff. 11/4/73; PRIOR p. 16-375; AMD, MAC Notice No. 16-2-31; Order MAC No. 16-2-11; Adp. 7/19/74; Eff. 9/5/74; PRIOR p. 16-387, 391, 393, 393.1, 393.4.).

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